Management Indicator Species Assessment

Carson National Forest

USDA Forest Service - Southwestern Region

September 2011

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Changes from the 2007 MIS Assessment

This document presents an update to the revised 2007 Management Indicator Species Assessment for the Carson National Forest. It includes additional national, regional, local, or forest-wide information for each species obtained over the past 4 years. This assessment updates both population and habitat trends for each species. References cited and used in the assessment have been brought up to date as well.

Over the past 4 years, little has changed on the Carson National Forest relative to MIS habitat trends. Any changes to MIS habitat were made in the corresponding section. The Appendix only shows how habitat trends were determined across the forest for each MIS and was not updated from the 2007 assessment.

INTRODUCTION

The land and resource management plan for the Carson National Forest (hereafter referred to as the Carson Forest Plan), initiated in 1986, was prepared in accordance with the implementing regulations established in 1982 for the National Forest Management Act. These regulations (36 CFR 219) outlined the process for developing a forest plan. They also provided guidance for selecting management indicator species (MIS) and included requirements for MIS monitoring population trends and determining relationships to habitat changes.

Management indicator species were identified during the development process of the forest plan. The 1986 Carson Forest Plan designates specific MIS with habitats that could best be used to analyze the effects of site-specific proposals on the Forest. Contained in this document are the profiles of the MIS identified for the Carson National Forest. Management indicator species are a subset of all animal and plant species in a planning area selected for planning and management purposes. Management indicator species are defined in the Carson Forest Plan as, "[t]hose species selected in the planning process to monitor the effects of planned management activities on viable populations of all wildlife and fish species, including those species that are socially or economically important" (USDA 1986c, Glossary p. 301). These species are:[1]

Table 1

MIS	Habitat
Brewer's sparrow	sagebrush
Juniper (plain) titmouse	piñon-juniper canopies
Abert's squirrel	interlocking canopies
Hairy woodpecker	snag
Red squirrel	mixed conifer
Elk	general forest
Wild Turkey	old growth pine (roost tree, roost tree groups)
White-tailed ptarmigan	alpine tundra, subalpine deciduous shrub
Bighorn sheep	alpine, subalpine tundra mountain meadow grassland
White-tailed ptarmigan	alpine tundra, subalpine deciduous shrub
Resident trout	perennial stream, riparian
Aquatic macro-invertebrates	perennial stream, riparian

Management indicator species are selected to monitor the effects of planned management activities on populations of fish and wildlife species. Monitoring MIS habitats and determining how habitat trends relate to population trends can help identify what impacts management activities have on wildlife and their habitats on the Carson National Forest.

In order to inform the decision maker of the progress toward achieving the goals, objectives, and standards and guidelines, Chapter 5 of the Carson Forest Plan (USDA 1986c, p. 237) lists items to be monitored, including, "population and habitat trends of management indicator species." Chapter 5 also provides several possible monitoring methods for nongame animal

[1] This list is taken from the Environmental Impact Statement for the Forest Plan (USDA 1986a, p. 97).

(birds only), game animals, threatened and endangered species, State listed species, sensitive plants, and fish and aquatic invertebrates. These should not be interpreted as required methods, only as suggested approaches. The Wildlife section of Chapter 5 concludes with the following statement:

> It should be realized monitoring of wildlife resources on such a scale as proposed is at best tentative and exploratory. State-of-the-art knowledge indicates it is a suitable system at the present time, but it must be noted that modifications may be needed within the planning period to better indicate the effects of National Forest management activities on the Carson's wildlife resources (USDA 1986c, p. 244).

The Carson Forest Plan allows flexibility on how MIS habitat and population trends are monitored. Each MIS profile in this document incorporates the best available science and data using the most up-to-date monitoring methods to determine habitat and population trend for the species.

RECENT COURT RULING AND FOREST PLAN MIS MONITORING

The introduction to Chapter 5 (Monitoring Plan) of the Carson Forest Plan (USDA 1986c, p. 235) provides: "The purpose of monitoring and evaluating the implementation of the Forest Plan is to inform the decision maker of the progress toward achieving the goals, objectives, and standards and guidelines." This language indicates the Monitoring Plan's purpose is to help the Carson National Forest achieve its goals in the Forest Plan. A recent court case included a challenge to the purpose of MIS monitoring as stated in Chapter 5 of the Carson Forest Plan and the Agua/Caballos site-specific decision on the El Rito Ranger District, Carson National Forest.

In *Forest Guardians and Carson Forest Watch v. U.S. Forest Service* (CIV 05-0372 JB/DJS), plaintiffs argued the Forest Service violated NFMA's consistency provision by not complying with the Forest Plan's Monitoring Plan requirements as a part of the Agua/Caballos decision. The Court found the MIS monitoring requirements in the Carson Forest Plan's Monitoring Plan "do not constitute a condition precedent to project approval and thus the deficient monitoring claim is not cognizable" (*FG et al. v. USFS* p. 39). The Court (pp. 40-41) found "nothing in the Monitoring Plan that conditions a project's approval on fulfilling certain requirements of the Monitoring Plan -- specifically here, there is no such language in the Monitoring Plan concerning the five years of baseline data for MIS or other monitoring methodologies."

The Court concluded by stating, "[t]he Monitoring Plan itself is not a prescription or standard, but rather gives information to the decision maker on progress towards those standards. This provision does not appear to the Court to create a condition precedent to site-specific approval of projects, nor does it tie specific monitoring of MIS to project approval as a 'standard'…" (*FG et al. v. USFS* p. 44). In essence, the Forest Plan's Monitoring Plan outlines monitoring to assess the effects of plan implementation on various resources, including MIS, over time.

MONITORING MIS HABITAT TRENDS

The 1986 Environmental Impact Statement (EIS) for the Carson Forest Plan described the habitat groups and characteristics along with projected trends of management indicator species, based on current direction and management of these habitats. The basis for determining habitat trend is a comparison of estimated MIS habitats at the time of preparing the Forest Plan to the present. The methods used to determine current habitats were developed to approximate

similarity (to the degree possible) to the acreages used in the 1986 Forest Plan EIS. In some cases, the estimated acres of MIS habitats are based on certain parameters of habitat quality. The rationale and methods used to reach the current habitat estimates are described for each species or group. The methods generally included developing queries from existing stand exam data. The processes used for determining habitat trends for the Carson National Forest's management indicator species are outlined by species at the end of this document in an appendix called "Rationale for Determining Habitat Trend Lines."

This forest-wide MIS assessment provides information on the relationship of the species to a forest community(s), forest successional class(s),[1] aquatic community(s), rare community(s) or relevant habitat parameters. These relationships are supported by documentation of published/unpublished research, professional opinion, administrative studies/surveys, effectiveness monitoring or from ongoing research/validation monitoring.

MONITORING MIS POPULATIONS TRENDS

Because methods to determine population numbers and/or estimate trends vary by species, conclusions that relate population trends to habitat conditions are also reached through a variety of methods. This assessment uses a combination of methods to determine the population trend for each of the MIS identified for the Carson National Forest. Information sources on MIS populations include (but are not limited to) the BISON-M, Biota Information System of New Mexico (2011), National Forest System (e.g., local Forest and Regional data), Forest Service Research (e.g., Forest Service Intermountain Research Station literature), university research, other federal and state government agencies (e.g., Patuxent Wildlife Center breeding bird surveys) and an assortment of non-governmental organizations (e.g., Partners in Flight, NatureServe Explorer).

From known relationships between species and habitat, trends in amount and condition of habitat over time may also reflect population trends. This is not necessarily the situation in all circumstances. Population trends can often relate to other outside forces, such as predation, nest parasitism, detrimental impacts to other migratory habitats, or climatic changes. To help determine population trends for each MIS, this assessment uses a step-down method. The Forest reviews and document information related to a species, beginning with information at a very broad scale going down to a Forest level or other local information.

Since there has been some misunderstanding in the use of Breeding Birds Surveys (BBS) information to help determine population trends, the assessment documents how this data is currently being used. BBS data are useful, but do not provide a population estimate for species. Appropriate use of the information involves estimation of population trend for a specific time interval. Overall, BBS trend information compares well to local, site specific studies although few comparisons have been made for the western U.S. The use of BBS trend information at state and physiographic province (including Bird Conservation Regions) scales is reliable and appropriate for common species (USDA 2006). To help show the regional and New Mexico population trend for bird species we use the state and physiographic province BBS information along with NatureServe ranking and other data that is available at that scale. While the Forest does review and document the data from local transects, these are only used to see how they correlate with other local or Forest-wide data.

[1] Forest succession is the change in vegetation and in animal life that takes place as a plant community evolves from bare ground to climax (Managing Forested Lands for Wildlife 1987). The steps or classes in the process of ecological succession are referred to as "seral stages."

POPULATION VIABILITY

The FEIS for the Carson Forest Plan analyzed seven alternatives (USDA 1986a). Each of the alternatives proposed a combination of management activities that, if implemented, would continue to maintain viable wildlife populations, including MIS. The Carson Forest Plan decision alternative is described relative to projected impacts on management indicator species over the life of the plan. The FEIS describes,

> The Proposed Action [decision] will over time provide moderate to high amounts and quality of most habitat components within the suitable timberlands and other management areas. Requirements for management of old growth, cover, vegetative diversity, raptor nesting habitat and many other habitat components receive greater emphasis and specific direction than other alternatives. Populations of all indicator species, with the possible exception of certain rare animals, will be managed at levels greatly exceeding minimum viable populations (USDA 1986a, p.152).

Population viability was determined with the development of the Carson Forest Plan. Since all management activities implemented on the Carson National Forest are consistent with the Forest Plan, then population viability is being maintained. For example: Figure 1 shows the projected harvest level over the period of the Forest Plan compared to the actual harvest from 1986 to 2010. The FEIS determined that MIS would be managed at levels greatly exceeding viable populations at the projected harvest levels. The actual harvest level on the Carson National Forest has averaged only about 30 percent of what was projected; therefore it is assumed the Forest is well within its ability to maintain viable populations for MIS *dependent on forested vegetation*.

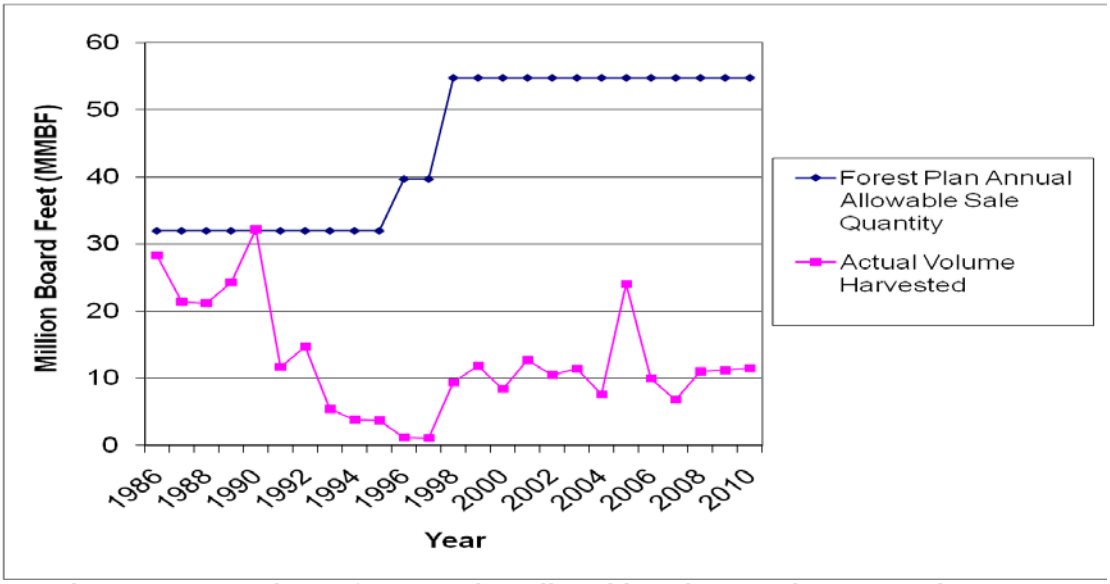


Figure 1. Comparison of Forest Plan Allowable Sale Quantity to Actual Harvest

REFERENCES

USDA Forest Service. 1986a. Environmental impact statement, Carson forest plan. Albuquerque, NM: US Department of Agriculture, Forest Service, Southwestern Region. 386 p.

USDA Forest Service. 1986b. Record of decision for the Carson National Forest land and resource management plan. Albuquerque, NM: US Department of Agriculture, Forest Service, Southwestern Region. 6 p.

USDA Forest Service. 1986c. Carson National Forest land and resource management plan, as amended. Albuquerque, NM: US Department of Agriculture, Forest Service, Southwestern Region.

USDA Forest Service. 1987. Terrestrial ecosystems survey of the Carson National Forest. Albuquerque, NM: US Department of Agriculture, Forest Service, Southwestern Region. 552 p.

USDA Forest Service. 2003a. Carson National Forest stand exam summary by cover type (unpublished). 1 p.

USDA, Forest Service. 2003b. Management indicator species for the Carson National Forest – July 2003. Unpublished. 147 p.

USDA Forest Service. 2006. Use of North American breeding bird surveys on region 3 national forest and grasslands with an annotated bibliography. Unpublished briefing paper by Ernest Taylor, Regional Biologist, Southwestern Region, Albuquerque, NM. 13 p.

USDA, Forest Service. 2007. Management indicator species for the Carson National Forest – July 2007. Unpublished. 170 p.

USDA Forest Service. 2010. Carson National Forest stand exam summary by cover type (unpublished). 1 p.

Brewer's Sparrow (*Spizella breweri*)

INDICATOR SPECIES HABITAT

On the Carson National Forest, the Brewer's sparrow (*Spizella breweri*) is an indicator species for sagebrush (USDA 1986a, p.97). In northern New Mexico, the habitat for the Brewer's sparrow is sagebrush, brushy plains, and the interface of piñon-juniper woodlands and sagebrush. The species prefers brushy conditions intermixed with grasses and grass understory. The Brewer's sparrow is strongly associated throughout its range with high sagebrush vigor (Knopf et al. 1990), preferring areas dominated by high shrub cover, large patch size, and bare ground (Rotenberry and Wiens 1980). The species is generally considered a "sagebrush obligate" (Walker 2004). The species can also be found to a lesser extent in mountain mahogany, rabbitbrush, bunchgrass grasslands with shrubs, bitterbrush, *Ceonothus* spp., manzanita, and large openings in piñon-juniper (Knopf et al. 1990; Sedgwick 1987; Walker 2004).

Brewer's sparrows breed in North America and winter primarily south of the US-Mexico border. The sparrow can be abundant in sagebrush habitat and will breed in high densities, but densities may vary greatly from year to year (Rotenberry et al. 1999). It prefers to nest low (from a few centimeters to about 1 meter above ground) in sagebrush, other shrub, or cactus. Nests are higher in taller sagebrush (Walker 2004).

Potential Habitat Distribution

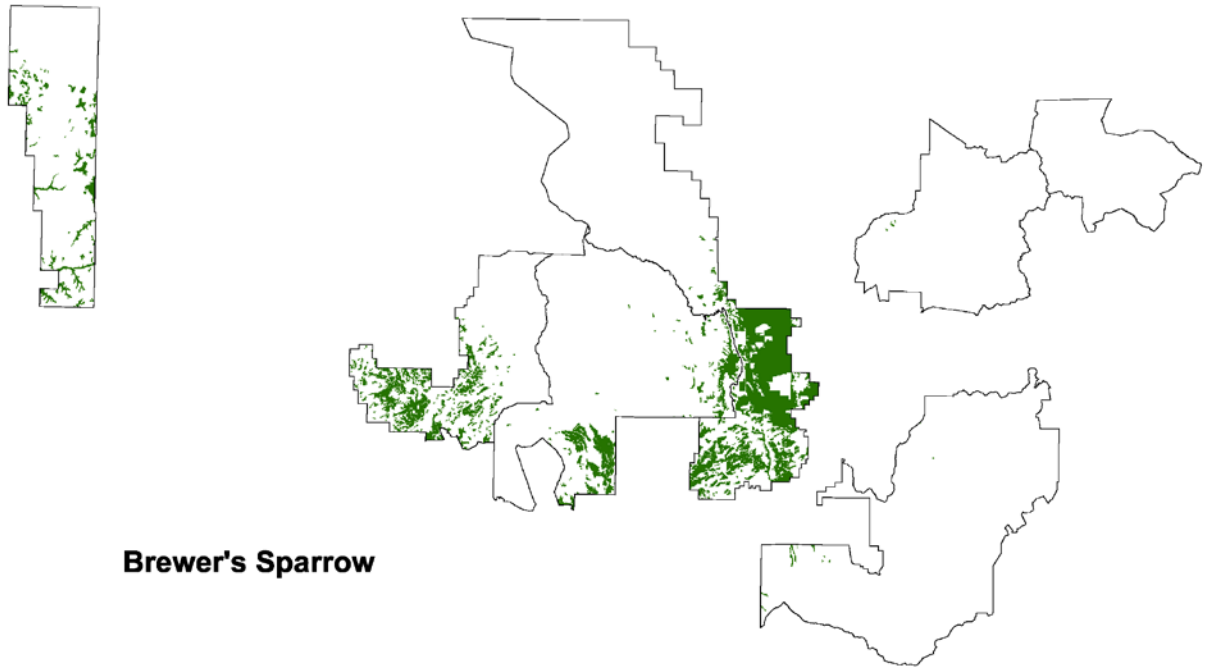
It should be noted that recent Geographic Information System (GIS) vegetation layer data for the Carson National Forest was considered for the potential habitat distribution map of Brewer's sparrow. The vegetation layer was used to approximate occupied habitat, but not for the purpose of "potential habitat distribution." Many acres in the Forest Plan EIS (USDA 1996a) identified as piñon-juniper habitat acres have a very strong sagebrush component. For example, sagebrush may be a codominant species in an area, but piñon-juniper may be the dominant cover type. There are many areas that have more than adequate habitat to support Brewer's sparrow, but are mapped as piñon-juniper, the dominant cover type. Therefore, a significant amount of suitable habitat would not be included in a potential distribution map using just the vegetation cover type.

Suitable habitat includes sagebrush-dominated scrublands with >10 percent average shrub cover and an average shrub height of 0.5 – 1.5 meters (Walker 2004). The following distribution map is based on the Terrestrial Ecosystem Survey (TES) map units for the Carson National Forest. Each map unit was evaluated and those having 10 percent or greater sagebrush cover were identified as potential habitat.

The Carson National Forest supports an estimated 343,974 acres of "potential" Brewer's sparrow habitat (USDA 1987). The potential habitat for the Brewer's sparrow is abundant and distributed across the Forest. There is a general correspondence to Forest Plan Management Areas 8 (Piñon/Juniper), 10 (Low Elevation Grasslands), 11 (Revegetation Areas), and 12 (Sagebrush) (USDA 1986c).

Based on the refinement of data and stricter criteria for habitat suitability, a number of acres were eliminated as potential habitat from what was shown in the 2003 Management Indicator Species Assessment for the Carson National Forest (USDA 2003). Most of these areas were piñon-juniper that did not have as strong of a component of big sagebrush. However, a number

of the areas that were eliminated are also affected by bark-beetle mortality and could see an increase in a shrub component in the future.



Map 1. Brewer's Sparrow Potential Habitat Distribution on the Carson National Forest (USDA 1987)

Management Activities or Natural Events That May Affect Habitat

Negative: Mechanical, chemical, or prescribed burning treatments of sagebrush, as well as, the encroachment of piñon and juniper trees to the point where shrubby dominance is diminished.

Energy development and natural resource extraction directly alter sagebrush habitats at the site of operation. Associated road networks, pipelines, and power transmission corridors fragment habitat and/or create soil conditions facilitating the spread of invasive species; the cumulative effects of energy development have not been assessed. The density of sagebrush obligate birds within 100 m of roads constructed for natural gas development was 50 percent lower than at greater distances. Increased numbers of corvids and raptors associated with power lines also increase the potential impact of predation on sagebrush-breeding birds (Holmes and Johnson 2005).

Activities such as grazing that lead to the increase of brown-headed cowbirds, which could lead to cowbird brood parasitism of Brewer's sparrows (Holmes and Johnson 2005).

Note: There are mixed reviews on effects of grazing on sagebrush obligate species like the Brewer's sparrow. As stated in the 2003 Management Indicator Species Assessment for the Carson National Forest (USDA 2003), sparrows that use grasslands for breeding and/or wintering do not seem to respond to grazing; therefore livestock grazing is not considered an impact on the Brewer's sparrow habitat. However, Bradford and others (1996) determined the relative abundance of Brewer's sparrows and other obligate shrub species were generally lower for rangelands impacted by higher grazing.

Positive: Encroachment of sagebrush into converted grasslands.

Plans, Regulations, and Guidelines Supporting, Maintaining or Improving Habitat

- *Carson National Forest Land and Resource Management Plan, Forest-wide Wildlife and Fish* (USDA 1986c), requires,

> for nontimber species, such as piñon-juniper, oak and sagebrush, standards and guidelines are established for the maximum size, dispersal and duration of created openings. These standards and guidelines are designed to address concerns for wildlife and plant species (USDA 1986c, p. Wildlife & Fish – 6).

HABITAT CONDITION AND TREND ON THE CARSON NATIONAL FOREST

Habitats dominated by sagebrush and areas with a mosaic of sagebrush and grasslands provide for optimal Brewer's sparrow population density. Entire removal of sagebrush in large blocks (> 40 acres) will decrease population density (Braun et al. 1976). Mosaic patterns, narrow strips or small blocks can be utilized to intersperse grassland and sagebrush to the benefit of non-game species, such as the Brewer's sparrow (Peterson and Best 1987).

The Forest Plan EIS identifies sagebrush as the habitat type for this species (USDA 1986a, p. 97). At the time the Forest Plan was implemented, 52,600 acres of occupied or quality[1] Brewer's sparrow habitat were identified for the Forest. It was expected the habitat would remain relatively consistent along with populations.

Overall habitat for this species has expanded considerably during the past several decades. During the 1950's, 60's, and 70's, piñon-juniper woodlands on the Carson National Forest were removed to increase forage for livestock grazing. Plowing of sagebrush and reseeding to grasses occurred during the same period. Since then, most of these revegetation areas have experienced transition from grasslands to a sagebrush community, increasing habitat for Brewer's sparrow. In some of these areas, prescribed fire has been (and still is) used to sustain grasses and forbs, but burning treatments have not been enough to offset the increase in the overall sagebrush habitat type.

Additional habitat has likely been created by epidemic infestations of bark beetles in piñon-juniper woodlands on the Carson in the early 2000's. An estimated 5 – 10,000 acres of piñon-juniper woodlands were decimated by the beetle infestation (Fruits pers. comm. 2011). A portion of the remaining landscape has likely converted to sagebrush or related communities favored by the Brewer's Sparrow.

For the past 25 years, the trend on the Carson has seen an increase in habitat for the Brewer's sparrow, despite the occasional maintenance of grasslands through prescribed burning. Based on the most recent evaluation of the GIS vegetation data layer, there was a total of 81,752 acres of sagebrush dominated habitat. In this case, the current vegetation cover layer was used to express habitat trend. In an appendix, a management indicator species habitat trend analysis explains in more detail how habitat trend is determined.

Habitat trend for Brewer's sparrow on the Carson National Forest has remained stable. Existing habitat for the Brewer's sparrow on the Carson National Forest is in good condition with a stable to upward trend.

[1] The definition of "occupied" and "quality" habitat is found in the introduction to this assessment.

The upward trend is mainly due to the reestablishment of sagebrush in large areas of revegetation treatments, which converted both piñon and juniper and sagebrush to grasslands in the 1960's. A total of 83,142 acres of vegetation treatments (Management Area 11) were not included in either the sagebrush or piñon-juniper habitats at the time of the analysis of the Forest Plan. Many of the acres of both conversion types have gradually transitioned from grasslands to sagebrush, which accounts for the significant upward trend in habitat. Some sites are shifting from sagebrush back to piñon-juniper. Others have been maintained through prescribed burning and are not expected to shift from grassland to sagebrush.

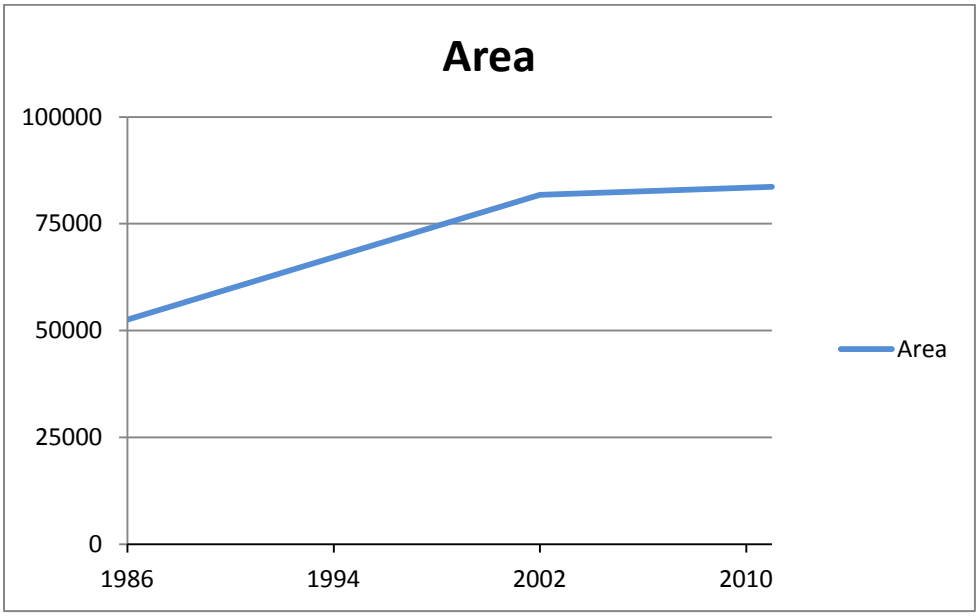


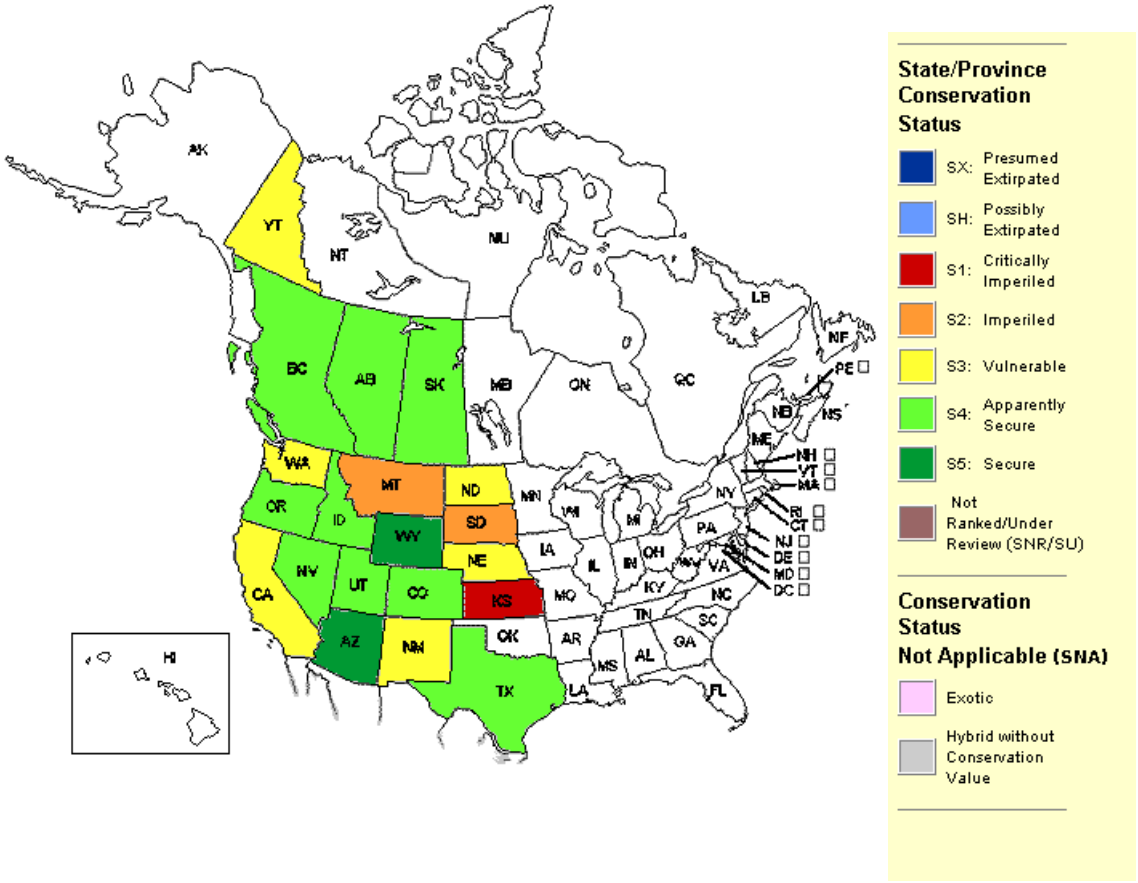
Figure 1

Figure 1. Changes in Brewer's Sparrow Suitable Habitat on the Carson National Forest 1986 - 2011

As of 2011, the numbers supporting this trend (above chart) remain virtually unchanged from the 2007 Forest-wide MIS Assessment (USDA 2007); however the amount of habitat loss on the Jicarilla Ranger District was not entirely considered, as well as approximately 1,000 acres of sagebrush removal that was done on the Canjilon and El Rito Ranger Districts. The removal of sagebrush for gas extraction (road construction and well pad development) has increased in the 2000's. However, throughout the decade, there has been a significant shift from piñon to sagebrush habitats, as the bark beetle impacts from 2000 to 2006, have been realized. It will likely take about a decade to see how extensive this shift will actually be.

POPULATION TREND

Throughout its range, the Brewer's sparrow is listed as G5 (i.e., globally secure and common, widespread, and abundant) (NatureServe 2010). It is apparently secure in most of its range. Species with this rank typically occur in more than 100 localities, and number more than 10,000 individuals. Within the United States, it is listed as N5, that is, it is secure and common, widespread and abundant.



Map 2. Distribution of Brewer's Sparrow in North America (NatureServe Explorer 2010)

The Brewer's sparrow breeds from southwestern Yukon, southern Alberta, southwestern Saskatchewan, south (east of the Cascades and Sierras) to southern California, central Arizona and northern New Mexico. It winters in the southern parts of the border states into northern Mexico. In the Southwest, it summers in northern New Mexico, southward to the Gallup and Santa Fe areas. It occasionally breeds into eastern New Mexico and westward to the Mogollon Plateau in Arizona.

In the Southern Rockies, the North American Breeding Bird Survey (BBS) has compiled estimated trends for the Brewer's sparrow within three guilds, successional/scrub habitat, cup nesters, and ground or low nesters (Sauer et al. 2008). Analyzing species within guilds (groups with similar life history traits) can provide additional insight into patterns of population trends. These trend estimates have been adjusted in order to take into account the relative precision of the estimated trends and provide a better ranking of change for the species relative to other species in the same guilds. The three adjusted trend estimates for Brewer's sparrow (across 109 routes) each indicated a nonsignificant regional trend (Sauer et al. 2008).

Table 1. Trend Estimates (across 109 routes) in Southern Rockies/Colorado Plateau (Sauer et al. 2008)

Guild	Adjusted Trend Estimate	P Value	Trend
Successional/scrub breeding	0.6530	P>0.1	Nonsignificant Increase
Cup nesters	0.6495	P>0.1	Nonsignificant Increase
Ground or low nesters	0.6730	P>0.1	Nonsignificant Increase

Although the three guilds have shown a nonsignificant increase for the Brewer's sparrow in the Southern Rockies/Colorado Plateau Region, overall the BBS for the Southern Rocky Mountain Region has shown a 0.7 percent change per year (Sauer et al. 2008).

The US Fish and Wildlife Service did include the Brewer's sparrow in the 2008 Birds of Conservation Concern for Bird Conservation Region16 (Southern Rockies/Colorado Plateau) (USFWS 2008, p. 32). The overall intent of this document is to accurately identify the bird species that represent the highest conservation priorities and conservation action outside of Federal listed species (id.)

It is probable the large areas of sagebrush that were type converted to grasslands throughout the Southwest during the middle part of the last century negatively impacted the sparrow. As habitat increases after years of sagebrush and piñon-juniper treatments, an increase in sparrow numbers is a likely response. From 1980 to 2003 (which most closely corresponds to the period of the Forest Plan), the overall trend for the Southern Rockies is up by 1.2 percent (Holmes and Johnson 2005).

New Mexico

The Brewer's sparrow is a migratory bird that breeds during the summer months in New Mexico. Statewide, it is considered to be rare to locally abundant (Hubbard 1970). The bird is a spring, fall and/or summer resident in the Chavez, Eddy, Lincoln, Socorro, and Taos counties.

In New Mexico, the Brewer's sparrow is listed as S3, meaning it is vulnerable in the state either because it is rare or uncommon, or found only in a restricted range (even if it is abundant at some locations), or because of other factors making it vulnerable to extirpation. Species with this rank typically occur in 21 to 100 localities, and number between 3,000 and 10,000 individuals (NatureServe 2010). However, monitoring information from the North American Breeding Bird Survey in New Mexico from 1968 to 2007 indicate population and trends are fairly stable for the entire state (Sauer et al. 2008).

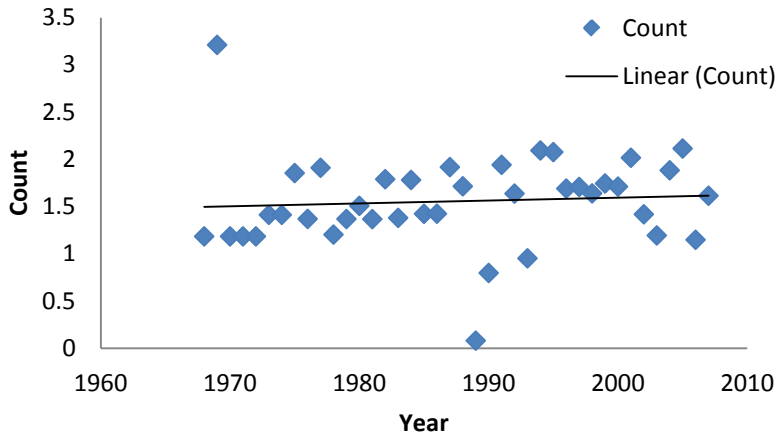
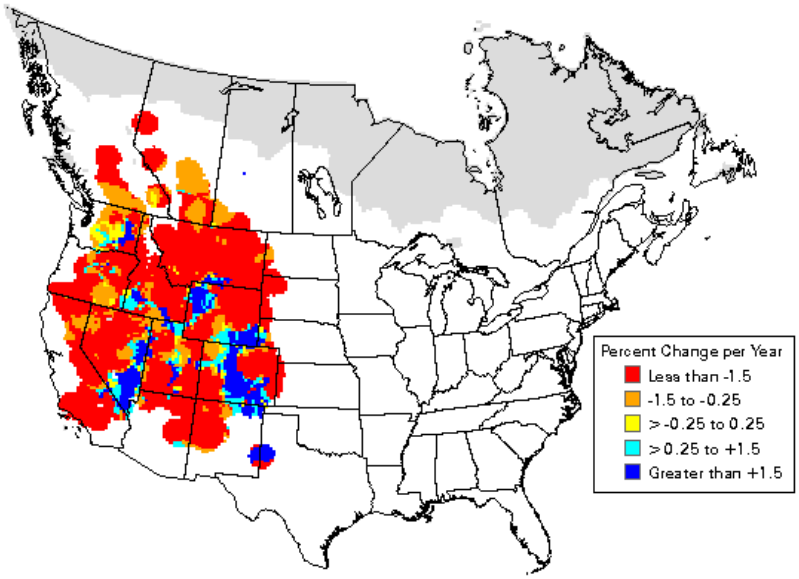


Figure 2

Figure 2. Estimated Trend for Brewer's Sparrow in New Mexico (Sauer et. al 2008) with Linear Regression Line Added

Breeding Bird Survey results allow an analysis of trend by species and state. For the Brewer's sparrow in New Mexico from 1968 through 2007, the estimated trend is 0.3 percent change per year (Sauer et al. 2008). This trend estimate is a summary of the population change over the last 36 years, and does not provide information on other patterns of population change (such as cycles) over time. Nine survey routes were used in this analysis, and the relative abundance of Brewer's sparrow observed per route was 1.56. These results corroborate the stable trend seen in the nation-wide and regional data above. The Brewer's sparrow is also not listed in the Land Bird Conservation Plan by New Mexico Partners in Flight (NMPF 2007). Not being on this list demonstrates there is no large-scale conservation concern for the Brewer's sparrow in New Mexico at this time.



Map 3. Percent Change in Breeding Bird Survey Trend Per Year for Brewer's Sparrow (Sauer et al. 2008)

Carson National Forest

The Brewer's sparrow occurs regularly and breeds in Taos and Rio Arriba Counties (NMDGF 2011). It resides in western Rio Arriba County on the Jicarilla Ranger District (Flippo 1979; LaGory et al. 2001, Beason and Giroir 2003).

Two Breeding Bird Survey routes have been used to evaluate trend for the Carson National Forest. Since the BBS routes that are located on the Carson do not go through sagebrush habitat, two routes adjacent to the Forest were selected for this analysis -- Stinking Lake, NM and Antonito, CO. The Brewer's sparrow was commonly detected on the Stinking Lake route from 1992 to 1999. Antonito Route has data from 1995 to 2002. Individual route trend estimates are seen in Figure 3.

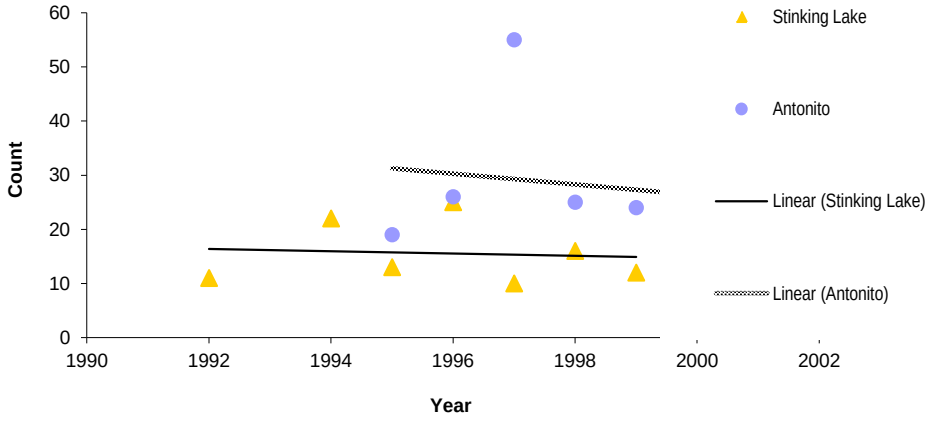


Figure 3. Time Series of Brewer's Sparrow for Stinking Lake and Antonito Survey Routes

Survey estimates for Stinking Lake and Antonito indicate a stable trend in Brewer's sparrow in sagebrush habitat adjacent to the Carson National Forest. Analyzing population change on survey routes is probably the most effective use of BBS data; however these data do not provide an explanation for the causes of population trends (Sauer et al. 2008).

Table 2. Breeding Bird Survey Estimates for Brewer's Sparrow

BBS Route	Trend Estimate	P value	Number of Years	Average Count
Stinking Lake	-1.35	0.83715	7	15.57
Antonito	1.79	0.88218	8	27.88

The removal of sagebrush in large blocks was likely related to a decrease in Brewer's sparrow in the past. As more sagebrush comes back into the man-made grasslands, habitat for the sparrow is likely to continue to increase and improve.

On lands administered by the Bureau of Land Management (BLM) just west of the Questa Ranger District in Taos County, New Mexico, a prey base analysis for the peregrine falcon conducted in spring and summer of 1985 and 1986 found an average 20.0 breed pair/40 ha (1.0 breeding birds/hectare) in the sagebrush grassland habitat type (Stahlecker et al. 1989).

Between 2003 and 2006, the Carson National Forest cooperated with the Rocky Mountain Bird Observatory to conduct avian inventories across a wide variety of vegetation types, including sagebrush habitats (Beason and Giroir 2003; Beason and Leukering 2004). In 2003, Brewer's sparrow was estimated to have a density of 0.0935 breeding birds per hectare in the sagebrush type. The species was also detected in both the piñon-juniper and grassland habitats. In 2004 the density was 0.6617 breeding birds per hectare. In 2005, the density was 0.3758 breeding birds per hectare in sagebrush and 0.0494 in piñon-juniper. In 2006, the density was 0.02 breeding birds per hectare in piñon-juniper and 0.26 in sagebrush (Beason et al, 2007).

Rotenberry (1999) states Brewer's sparrow population numbers are "highly variable, depending on habitat and year." For example, one site in Oregon sampled for seven years varied from 50 to 350 individuals/km^2 (0.5 to 3.50 individuals/ha). A site may be unoccupied in one year, then attain densities of 1.50 individuals/ha the next year. Because of high annual variation, estimates from small-scale or short-term studies must be handled with caution (Rotenberry 1999).

Across the Carson National Forest, the acreage of sagebrush has remained stable to increasing since the inception of the Forest Plan. In Revegetation Areas (MA 11) where sagebrush type was converted to grassland, the Carson Forest Plan says to "maintain revegetation sites in grassland communities…" (USDA 1986c). The effects analysis to implement the Carson Forest Plan took into account the maintenance of identified revegetation areas over the next 10 to 20 years.

The amount of sagebrush to be maintained as grassland on the Carson National Forest is about half of the acres in MA 11 or approximately 40,000 acres (~4000 ac/yr). Since the inception of the Forest Plan in 1986, the actual maintenance level of sagebrush on average has been 300 to 500 acres per year. The actual level of maintenance has averaged only about 12 percent of what was projected. This corresponds with the Carson Forest Plan's description of expected conditions for the Brewer's sparrow over the life of the plan – "…Brewer's sparrow populations may decrease over time in specific areas impacted by management activities, but populations will be maintained at levels greatly exceeding minimum viable populations" (USDA 1986c, p. 238).

Based on its current distribution throughout New Mexico and past habitat alterations, as well as, current management practices, the population trend for the Brewer's sparrow on the Carson National Forest is considered to be stable.

REFERENCES

Beason, Jason; Giroir, Glenn. 2004. Monitoring the birds of Carson National Forest: 2003 Final Report. Revised February 2004. Brighton, CO: Rocky Mountain Bird Observatory. 73 p.

Beason, Jason; Leukering, Tony. 2005. Monitoring the birds of Carson National Forest: 2004 Final Report. Brighton, CO: Rocky Mountain Bird Observatory. 107 p.

Beason, J., K. Hutton, R. Sparks, J. Blakesley, A. Panjabi and D. Hanni. 2006. Monitoring the birds of Carson National Forest: 2006 Field Season Report. Tech. Rep. M-CNF06-01. Rocky Mountain Bird Observatory, Brighton, CO, 88 pp.

Bradford, David; Franson, Susan; Neale, Anne; Heggem, Daniel; Miller, Glen; Canterbury, Grant. 1996. Bird species assemblages as indicators of biological integrity in great basin rangeland. Environmental Monitoring and Assessment: 49: 1-22.

Braun, C.E.; Baker, M.F. Eng, R.L.; Gashwiler, J.S.; Schroeder, M.H. 1976. Conservation committee reports on effects of alteration of sagebrush communities on the associated avifauna. Wilson Bulletin. 88: 165-171.

Flippo, Mark. 1979. Avian and rodent surveys in the Jicarilla Ranger District of the Carson National Forest, New Mexico.

Holmes, J.A.; Johnson, M.J. 2005. Brewer's sparrow (Spizella breweri): a technical conservation assessment. US Department of Agriculture, Forest Service, Rocky Mountain Region. 57 p.

Hubbard, J.P. 1970. Revised checklist of the birds of New Mexico. New Mexico Ornithological Society Publication No. 3.

Kennedy, Patricia; Stahlecker, Dale. 1986. Prey base analysis by habitat site, Taos Resource Area near Questa in Taos County, NM. Contract #YA-551-CT4-340074. Albuquerque, NM. USDI, Bureau of Land Management. 15 p.

Knopf, F.L.; Sedgwick, J.A.; Inkley, D.B. 1990. Regional correspondence among shrubsteppe bird habitats. Condor 92:45-53.

LaGory, Kirk; Chang, Young-Soo; Reeves, Timothy; Liebich, Richard; Smith, Karen. 2001. A study of the effects of gas well compressor noise on breeding bird populations of the Rattlesnake Canyon Habitat Management Area, San Juan County, NM. June 2001: Report DOE/BC/W-31-109-ENG-38-10. US Department of Energy. 81 p.

Mahony, Nancy; Vander Haegen, W. Matthew; Walker, Brett; Krannitz, Pamela. 2001. Male incubation and multiple brooding in sagebrush Brewer's sparrows. The Wilson Bulletin: Vol. 113, No. 4: 441-444.

NatureServe Explorer: An online encyclopedia of life [web application]. 2010. Version 7.1. Arlington, Virginia, USA: NatureServe. Available: http://www.natureserve.org/explorer. (Accessed: March 15, 2011).

New Mexico Partners in Flight. 2007. New Mexico Bird Conservation Plan Version 2.1. C. Rustay and S. Norris, compilers. Albuquerque, NM. 41 pages.

New Mexico Department of Game and Fish. 2011. BISON-M (Biota Information System of New Mexico): Biological database for New Mexico. NMDGF in cooperation with USDI BLM, USDI FWS, USDI Bureau of Reclamation, US Army Corps of Engineers, USDA Forest Service and University of New Mexico. http://www.bison-m.org. (Accessed: March 23, 2011)

Peterson, K.L.; Best, L.B. 1987. Effects of prescribed burning on nongame birds in a sagebrush community. Wildlife Society Bulletin. 15: 317-329.

Rotenberry, J.T.; Wiens J.A. 1980. Habitat structure, patchiness, and avian communities in North American steppe vegetation: a multivariate analysis. Ecology 61:1228-1250.

Rotenberry, J. T.; Patten, M. A.; Preston, K. L. 1999. Brewer's Sparrow (Spizella breweri). In The Birds of North America, No. 390 (A. Poole and F. Gill, eds.). The Birds of North America, Inc., Philadelphia, PA.

Sauer, J. R., J. E. Hines, and J. Fallon. 2008. The North American Breeding Bird Survey, Results and Analysis 1966 - 2007. Version 5.15.2008. USGS Patuxent Wildlife Research Center, Laurel, MD. Available: http://www.mbr-pwrc.usgs.gov/bbs/bbs.html. (Accessed: February 23, 2011).

Sedgwick, J.A. 1987. Avian habitat relationships in piñon-juniper woodland. Wilson Bulletin 99: 413-431.

Stahlecker, Dale W.; Kennedy, Patricia L.; Cully, Anne C.; Kuykendall, Charles B. 1989. Breeding bird assemblages in the Rio Grande Wild and Scenic River Recreation Area, New Mexico. Southwestern Naturalist. 34(4): 487-498.

Stahlecker, Dale W. 1996. Preliminary report on baseline wildlife populations in sagebrush habitat in the Urraca Wildlife Management Area, Taos County, New Mexico. Santa Fe, NM. Eagle Ecological Services.

USDI Fish & Wildlife Service. 2008. Birds of Conservation Concern 2008. Division of Migratory Bird Management, Arlington, Virginia. 85 p. Available: http://www.fws.gov/migratorybirds/NewReportsPublications/SpecialTopics/BCC2008/BCC2008.pdf.

USDA Forest Service. 2006. Use of North American breeding bird surveys on region 3 national forest and grasslands with an annotated bibliography. Unpublished briefing paper by Ernest Taylor, Regional Biologist, Southwestern Region, Albuquerque, NM. 13 p.

Walker, B. 2004. Effects of management practices on grassland birds: Brewer's sparrow. Jamestown, ND: Northern Prairie Wildlife Research Center. 32 p.

Juniper (Plain) Titmouse (*Baeolophus ridgwayi*)

INDICATOR SPECIES HABITAT

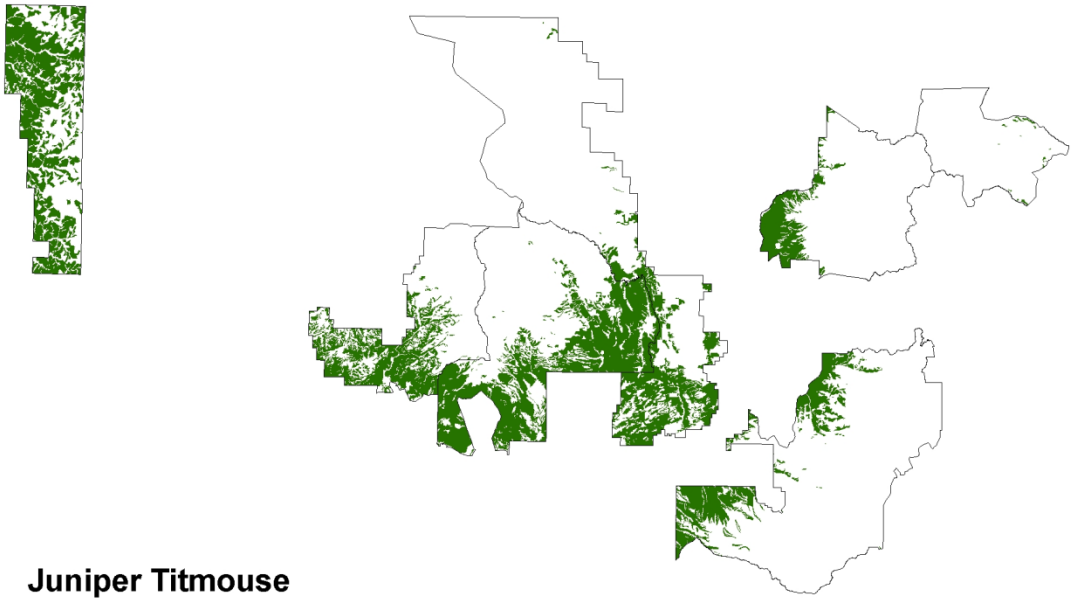
The plain titmouse is an indicator species for piñon-juniper (PJ) canopies (USDA 1986a, p. 97). Until 1997 the taxa was regarded as a single species (*Parus inornatus*). The taxa were split into two separate species; oak titmouse (*Baeolophus inornatus*) and juniper titmouse (*Baeolophus ridgwayi*). The oak titmouse is found in the oak woodlands of the Pacific and is not found in New Mexico (Cicero 2000). The juniper titmouse inhabits juniper and piñon-juniper woodlands of the intermountain region (id.). Further discussion in this document will call the species juniper titmouse, however, it is the same species identified as an indicator species in 1986 (USDA 1986a, p. 97).

The juniper titmouse is a resident of deciduous or mixed woodlands, favoring oak and piñon-juniper (Ehrlich et al. 1988). The titmouse usually nests in natural cavities or old woodpecker holes primarily in oak trees, but it is capable of excavating its own cavity in rotted wood. The species feeds mainly on large seeds from piñon pine and juniper, as well as, acorns (Christman 2001), insects, and occasional fruits, and is also a bark gleaner (Cicero 2000; Scott et al. 1977; Scott and Patton 1989). As a cavity nester, large, older senescent trees are an important habitat feature (Pavlacky and Anderson 2001).

Potential Habitat Distribution

Based on the 2003 GIS vegetation cover data, the Carson National Forest supports approximately 355,409 acres of piñon-juniper habitat (USDA 2003). As displayed on Map 1, potential habitat for the juniper titmouse on the Carson National Forest is abundant and well distributed across the Forest. It should be noted that these acres include all existing piñon-juniper as well as potential natural vegetation types as determined by Terrestrial Ecosystem Survey (TES) data (USDA 1987). Thus, there are slightly more acres on the potential habitat map than actual current cover type. Use of TES allows for the vegetation composition of each unit to be analyzed to determine habitat suitability. Generally the potential habitat distribution corresponds to the Forest Plan Management Areas 8 (Piñon/Juniper) and 11 (Revegetation Areas) (USDA 1986c).

Map 1. Juniper Titmouse Potential Habitat Distribution on the Carson National Forest (USDA 2010)



Management Activities or Natural Events That May Affect Habitat

Negative: Mechanical removal of piñon and juniper trees and wildfire in PJ woodlands.

Positive: Encroachment of piñon and juniper trees into sagebrush and grasslands.

Plans, Regulations, and Guidelines Supporting, Maintaining or Improving Habitat

- *Carson National Forest Land and Resource Management Plan, Forest-wide Wildlife and Fish* (USDA 1986c), requires:

> *for nontimber species, such as piñon-juniper, oak and sagebrush, standards and guidelines are established for the maximum size, dispersal and duration of created openings. These standards and guidelines are designed to address concerns for wildlife and plant species.*
>
> *In the piñon-juniper type, created openings in areas that have been identified as big-game winter range will be designed so that an animal will be no more than 600 feet from hiding cover at any location within the opening (USDA 1986c, p. Wildlife & Fish – 6).*

The desired condition for Management Area 8 is described as, "good habitat for plain titmouse." Maintain an average of 50 percent or more of piñon acres in a balanced age class distribution. In juniper areas there will be at least 10 large trees per acre. The trees will have greater than 25 percent living crown" (USDA 1986c, p. 8. Piñon-Juniper - 1).

HABITAT CONDITION AND TREND ON THE CARSON NATIONAL FOREST

The Forest Plan EIS identifies piñon-juniper as the habitat type for this species. The key feature used in the EIS to track juniper titmouse habitat was "piñon-juniper canopies" (USDA 1986a, p. 97). At the time the Forest Plan was implemented, 364,900 acres of juniper titmouse habitat were identified for the Forest. However, the difference between 364,900 acres in the Forest Plan and the 355,409 identified in the most recently evaluated vegetation cover map (USDA 2003) is due to a variation in habitat typing. There are often variations, especially in the piñon-

juniper sagebrush communities. For example, sagebrush may be the dominant species in an area, but scattered piñon and juniper may actually provide the structural difference necessary to influence species diversity. There are no set criteria for observers to break out this particular transitional portion of the community. Therefore, the 355,409 acres are used as the baseline to determine habitat trends, since this acreage can be tracked.

Since that time, stands have grown, some have been harvested, wildfires and disease have (to a degree) changed the landscape, and data to estimate conditions and cover types have also improved or changed in methods.

Several factors are used to determine habitat trend. Management activities (primarily timber sales) and wildfire have reduced certain habitats to unsuitable conditions. High intensity wildfire and certain harvest prescriptions such as overstory removal, seed cuts and shelterwood harvests are examples of areas that are deducted from the total acres of titmouse habitat. Extraordinary events, such as the bark beetle infestation in the first half of the 2000's, are also considered. Total stand acres are not deducted. Only the actual acres treated and estimated to result in acres becoming unsuitable are subtracted. In an appendix, a management indicator species habitat trend analysis explains in more detail how habitat trend is determined.

Suitable stands (2,720 ac) that experienced wildfire or prescribed fire were removed from titmouse habitat. Suitable habitat lost to fuelwood cutting (7,435 ac) and bark beetle infestations (1,875 ac) was also deducted. Only an estimated 25% of the 5,000 – 10,000 acres infested by bark beetles are assumed lost to grassland/sagebrush communities (Fruits pers. comm. 2011).

Table 1. Titmouse Suitable Habitat Acres: Change from Wildfire, Logging, and Tree Growth 1986-2011

Ranger District	Total PJ Acres	Habitat Acres Reduced by Wildfire & Rx Burning*	Habitat Acres Reduced by Fuelwood Cutting	Habitat Acres Reduced by Bark Beetles	Total Acres Reduced	Remaining Acres of Titmouse Habitat
D1, D2, D6[1]	204,328	20	1,500	N/A	1,520	202,808
D3	87,301	500	2,400	N/A	2,900	84,401
D4	41,444	100	60	N/A	160	41,284
D7	22,336	2,100	100	N/A	2,200	20,136
Total	355,409	2,720	7,435	1,875	12,030	343,629

*Numbers for habitat acres reduced by wildfire & Rx burning are through 2007; N/A: Unavailable

Table 1 does not include an ingrowth factor, since this habitat grows very slowly and is not likely to be significant enough to consider. Also fuelwood harvest, as with logging practices, changed during the period of the Forest Plan. Overstory removal was fairly common in the 1980's for fuelwood, in order to remove older trees and release the younger growth. Thus, the assumption the Forest Plan EIS makes is fuelwood harvesting would result in a downward trend in habitat (USDA 1986a). This was in part reversed by the early 1990's to maintain the larger trees and remove the crowding in the understory. The latter treatment would not affect the suitability of habitat for the juniper titmouse. The above numbers are estimated to reflect that trend. The table displays any harvest that would have removed or reduced habitat. Since the 2007 Management Indicator Species Assessment for the Carson National Forest (USDA 2007),

[1] D1 = Canjilon, D2 = El Rito, D3 = Jicarilla, D4 = Camino Real, D6 = Tres Piedras, D7 = Questa

approximately 150 acres have been reduced on the Jicarilla Ranger District that were directly related to gas well development. Note: At the discretion of the District Rangers, green tree fuelwood sales have been curtailed since the bark beetle infestation.

The trend in habitat acres shows a decrease from 355,409 to 343,629. **This is a downward trend of an estimated 11,780 acres, or about three percent of available juniper titmouse habitat on the Carson National Forest since 1986.** As stated in the 2007 Management Indicator Species Assessment for the Carson National Forest, "An additional reduction in habitat over time is expected as bark beetle impacts of the 2002 summer and fall are realized, especially if drought conditions continue on the Forest through 2007 (USDA 2007). The Carson National Forest, in conjunction with the Rocky Mountain Bird Observatory, conducted surveys on the Forest from 2003 to 2006 (Beason and Girior 2004; Beason and Leukering 2005; Beason et. al 2006; Beason et. al 2007). At this time, there has not been a definitive response by the species to determine what percent of piñon pine die off would preclude use by the juniper titmouse. They were still detected in areas of high piñon mortality, but it is uncertain if use of these areas will persist.

Forest Management Activities

There are several significant activities that have shaped or affected juniper titmouse habitat over the past several hundred years in northern New Mexico. Prior to 1848, many of the areas now occupied by dense woodlands were predominately open, diverse communities of trees, shrubs and perennial grasses and forbs (Dahms et al. 1997). By the mid-1800's, local use of woodlands for timber and fuelwood had a significant effect (Betancourt et al. 1993). Early settlers used the areas closest to their communities to support their primary agricultural and transportation tools -- horses and burros. Heavy grazing from these livestock led to a reduction in the number and intensity of wildfires, resulting in a significant expansion of piñon and juniper trees (Wright 1990). In addition, the larger trees and snags were commonly used as firewood. Fire suppression during the last century also contributed to increased density of piñon-juniper stands. Since the historic period, coniferous woodlands have aged and generally become more dense and extensive, primarily by expansion into grasslands. It is likely that the existing amount of juniper titmouse habitat is greater than what historically existed. However the quality of the habitat (small trees, densely growing together) is likely not as good as when trees were larger and growing further apart, providing better trees for cavity nesting and more grass in the understory to support a forage base of insects.

The most significant management activity in the Southwest that altered or destroyed habitat for the juniper titmouse was the plowing, chaining, dozer piling, tree crushing and hand clearing with chainsaws of piñon-juniper woodlands to create forage areas for livestock grazing. Beginning in the 1940's and continuing until the early 70's, there was a widespread effort to convert woodlands to grassland.

The Carson Forest Plan (1986c) defines approximately 83,000 acres on the Forest that were chained and reseeded as Revegetation Areas -- Management Area (MA) 11. About half of these type-converted acres were once piñon-juniper woodlands and the other half were in sagebrush. Although Forest Plan standards and guidelines for MA 11 direct the Forest to maintain these revegetation areas, the Carson has focused prescribed burning on mostly the acres that would naturally revert back to sagebrush. Piñon and juniper trees have gradually reestablished into many of the sites where the trees were once dominant. This management trend is likely to continue. It is unknown at this time how much the drought will affect the overall acreage on the forest.

Limiting factors for the juniper titmouse include cavities in snags and hollow trees. With about 348,729 acres of suitable woodland vegetation type on the Carson National Forest, cavities are expected to be abundant for this species. This is particularly true during this current period of drought, which has caused noticeable infections of insects and disease in piñon trees across the entire Forest, creating numerous snags.

The Forest Plan projected a harvest level in piñon-juniper of 9200 cords (4.6 million board feet) per year (USDA 1986a). Since the inception of the Forest Plan in 1986, the actual harvest level of piñon and juniper trees on average has been approximately 1100 cords per year. Since 2002, the harvest level has been further reduced to approximately 750 cords per year (Fruits, pers. comm. 2011). This translates into treatment of an estimated 375 acres of piñon-juniper woodland on the Carson National Forest each year.

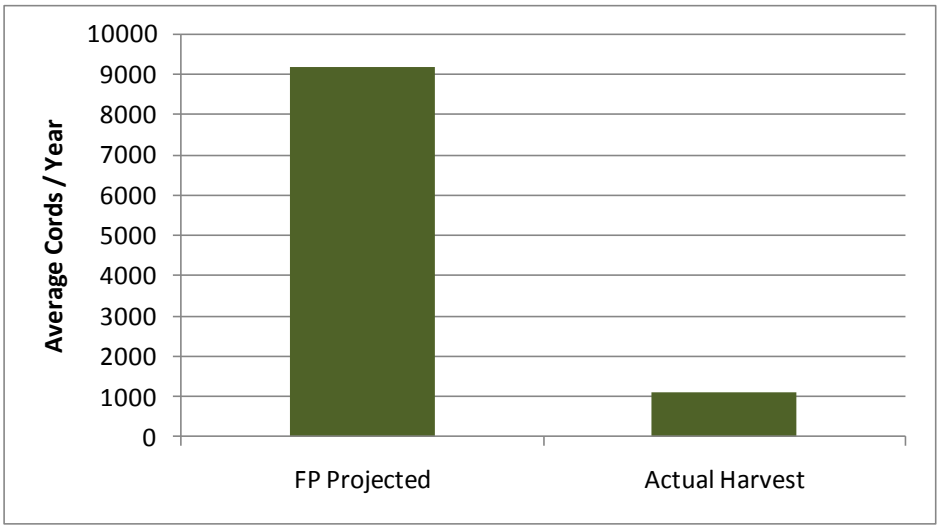


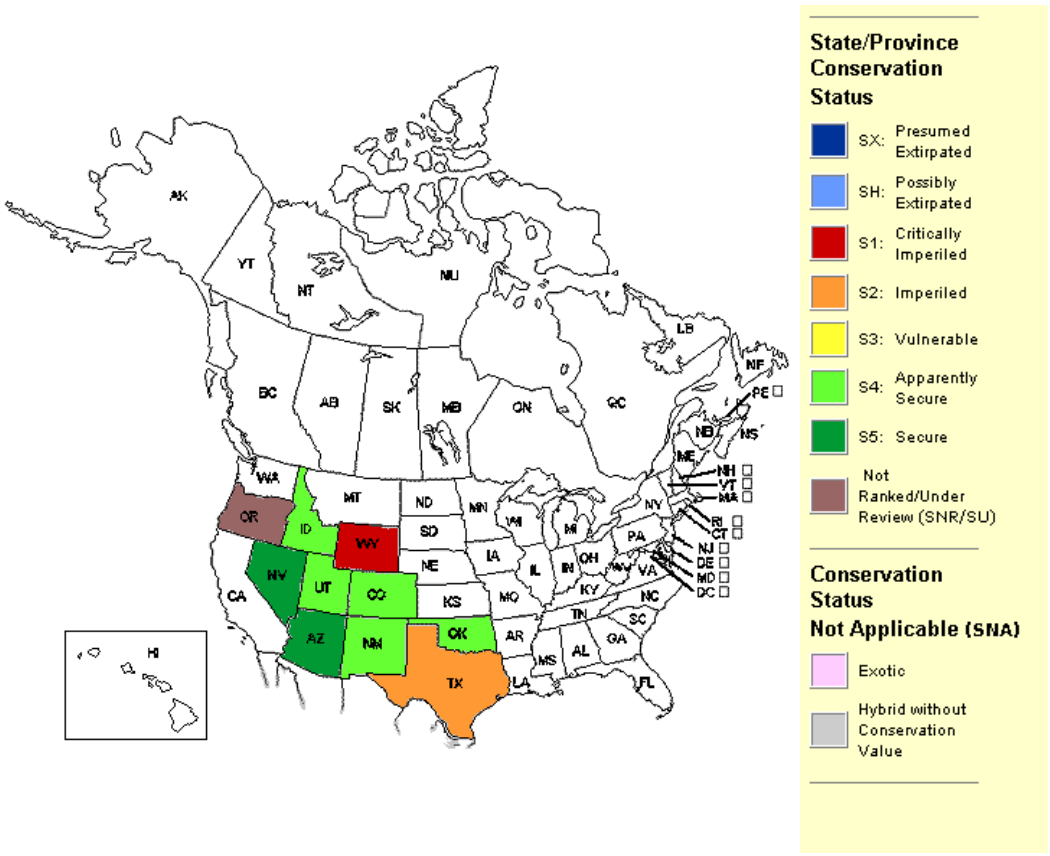
Figure 1. Comparison of Forest Plan Projections and Actual Harvest of Piñon-Juniper on the Carson (1986 – 2011)

The purpose of treating most of the piñon-juniper woodland on the Forest is to thin dense stands. Large trees are left for cavities and a more open understory supports a better forage base, therefore improving overall habitat for the titmouse. On the Jicarilla Ranger District, however, trees are harvested in piñon-juniper for the purpose of gas well development (road and well pad construction). These areas permanently remove piñon and juniper trees.

To stimulate trees to grow larger and improve understory forage, thinning and prescribed burning in Management Area 8 are priority treatments over the next ten years. These activities in piñon-juniper woodlands will continue to benefit the juniper titmouse. The primary threat to this species' habitat is wildfire and bark beetle.

POPULATION TREND

Throughout its range, the juniper titmouse is listed as G5, (i.e., globally secure and common, widespread, and abundant) (NatureServe 2010). It is not vulnerable in most of its range. Species with this rank typically occur in more than 100 localities, and number more than 10,000 individuals. Within the United States, it is listed as N5, that is, it is secure and common, widespread and abundant.



Map 2. Distribution of Juniper Titmouse in North America (NatureServe Explorer 2010)

Regionally (Arizona, New Mexico, and Texas), the North American Breeding Bird Survey (BBS) has compiled estimated trends for the juniper titmouse within three guilds, successional/scrub habitat, cavity nesters, and mid-story or canopy nesters (Sauer et al. 2008). Analyzing species within guilds (groups with similar life history traits) can provide additional insight into patterns of population trends. These trend estimates have been adjusted in order to take into account the relative precision of the estimated trends and provide a better ranking of change for the species relative to other species in the same guilds. The three adjusted trend estimates for the juniper titmouse (across 47 routes) each indicated a significant regional decline (Sauer et al. 2008).

Table 2. Trend Estimates (across 47 routes) in Arizona, New Mexico, Texas, and Oklahoma (Sauer et al. 2008)

Guild	Adjusted Trend Estimate	P Value	Declining or Increasing
Successional/scrub breeding	-1.8272	P<0.1	Significant trend
Cavity nesters	-1.5365	P<0.1	Significant trend
Canopy nesters	-1.8298	P<0.1	Significant trend

The BBS has shown a decline in population trend regionally and the Fish and Wildlife Service included the juniper titmouse in the Birds of Conservation Concern 2008 for Bird Conservation Region16 (Southern Rockies/Colorado Plateau) (USFWS 2008, p. 32). The overall goal of this

document is to accurately identify the bird species that represent our highest conservation priorities and conservation action outside of Federal listed species (id.)

New Mexico

The juniper titmouse is a year-round resident of New Mexico, and breeds during the summer months (Hubbard 1970). The juniper titmouse occurs almost statewide, and is considered rare to common. Its eastern limits are the dry Cimarron Valley, the lower Canadian Basin and the southeastern mountains (Scott and Patton 1989). The species occurs to the southwest of the Peloncillo and Organ Mountains, is common on the Zuni Indian Reservation, and rare, accidental (or casual) permanent-residents at the White Sands National Monument, in Dona Ana and Otero counties. In conversation with Greg Schmidt with the New Mexico Department of Game and Fish (June 1999), the species is widely distributed and fairly common.

In New Mexico, the juniper titmouse is listed as S4, meaning it is apparently secure, uncommon but not rare with some cause for long-term concern due to declines or other factors (NatureServe 2010). This matches the monitoring information from the North American Breeding Bird Surveys in New Mexico from 1968 to 2007 that indicate population and trends are slightly down for the entire state since 1968, but are fairly stable over the last decade (Sauer et al. 2008).

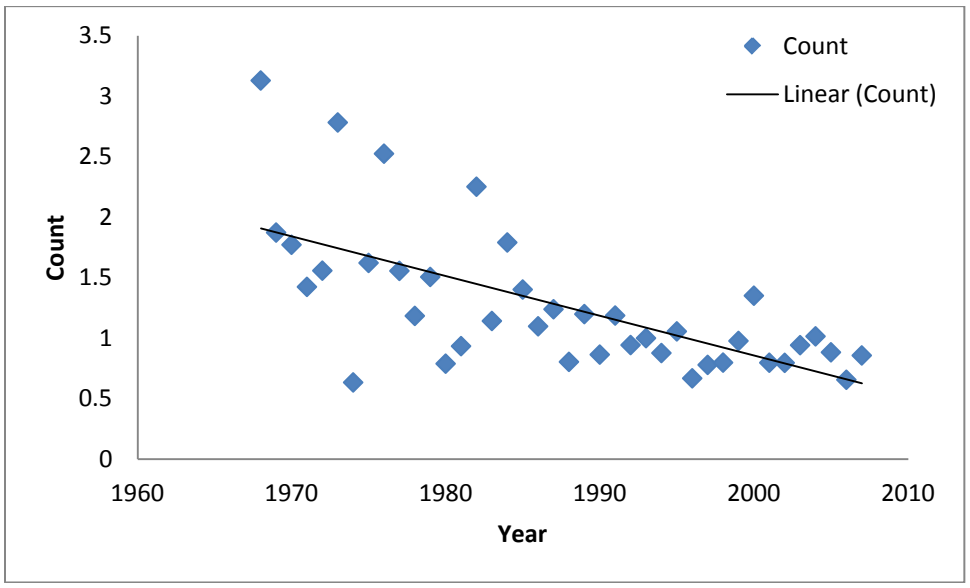
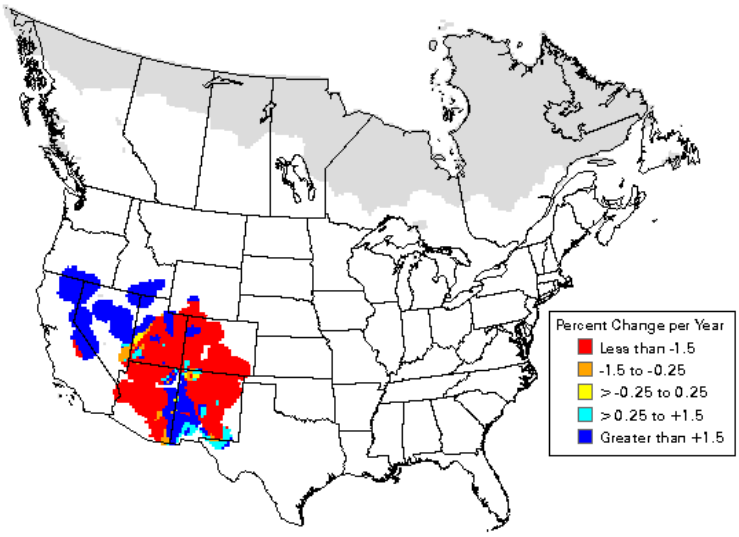


Figure 2. Estimated Trend for Juniper Titmouse in New Mexico (Sauer et. al 2008) with Linear Regression Line Added

Breeding Bird Survey results allow an analysis of trend by species and state. Per the 2007 Forest-wide MIS Assessment, the estimated trend was –2.7 percent per year from 1966 through 2004 for the juniper titmouse in New Mexico. However, the most recent data suggests a moderation in the declines in population for New Mexico since the 1990's. Map 3 is developed from the Breeding Bird Survey trends for the juniper titmouse from 1966 - 2003 and shows the percent change per year.



Map 3. Percent Change in Breeding Bird Survey Trend Per Year for Juniper Titmouse 1966 - 2003 (Sauer et al. 2008)

The juniper titmouse is listed as a High Responsibility species under the New Mexico Partners in Flight New Mexico Bird Conservation Plan (NMPF 2007). High Responsibility species are determined to be species that have 10 percent or more of their breeding population within New Mexico, therefore the state has a high level of responsibility for the species.

Carson National Forest

The juniper titmouse is a common inhabitant of the Carson National Forest, primarily in the piñon-juniper woodlands. Occasionally, it is observed within ponderosa and mixed conifer forest types. Incidental observations made by Forest Service biologists have found that it is regularly seen and well distributed during the spring and summer months.

Bird surveys in piñon-juniper and ponderosa pine habitat were performed as far back as 1979 on the Jicarilla Ranger District (Flippo 1979). Flippo found the titmouse in piñon-juniper, but not ponderosa pine. In conjunction with the Rocky Mountain Bird Observatory, four years of avian surveys have been conducted on the Carson National Forest during the 2003 through 2006 breeding seasons. A density of 0.1767 breeding birds/hectare were detected in 2003 with 138 individuals observed over 30 transects (Beason and Giroir 2004). A density of 0.1372 breeding birds/hectare was recorded in 2004 with 119 individuals observed in 26 transects (Beason and Leukering 2005). The 2005 surveys recorded 132 individuals with a density of 0.3138 breeding birds/hectare (Beason et. al 2006). The 2006 surveys recorded 133 individuals with a density of 0.22 breeding birds per hectare (Beason et. al 2007). The maps for the surveys conducted in 2003-2006 have shown that the juniper titmouse is found throughout their habitat on the Carson (Beason and Giroir 2004, Beason and Leukering 2005, Beason et. al. 2006, and Beason et. al 2007). Because of the significant insect infestation, drought, and mortality of piñon trees, more transects were chosen in the piñon-juniper than other habitats on the Forest. Biologists assumed there could be significant effects to its habitat and wanted a good understanding of the response juniper titmouse would have as a management indicator species to this event.

In the spring and summer of 1985, a prey base analysis study was conducted in an area just west of the Questa Ranger District on public lands administered by the Bureau of Land Management (BLM) (Stahlecker et al. 1989). Data for this species comes from the piñon-juniper and wooded canyon bench habitat, similar to the piñon-juniper woodland and transition zone between the piñon-juniper and ponderosa pine type prevalent across the Carson National Forest. The wooded canyon bench habitat contains a mix of juniper, piñon, and ponderosa pine. Stahlecker recorded 24.5 breeding pairs per 40 hectares (1.25 breeding birds/hectare) in the piñon-juniper woodland and 8.9 breeding pairs per 40 hectares (0.44 breeding birds/hectare) in the wooded canyon benches (Stahlecker et al. 1989). There is a high degree of similarity between BLM piñon-juniper woodlands and adjacent Forest habitats.

Cicero (2000) notes the oak titmouse population density has been studied more than the juniper titmouse. The oak titmouse average densities of pairs range from a low of 0.3-0.4 breeding pairs per hectare (0.6-0.8 breeding birds/hectare) up to 1.2 breeding pairs per hectare (2.4 breeding birds/hectare). In western Nevada, juniper titmouse densities were reported to be between 0.1 to 0.5 breeding pairs per hectare (0.2-1.0 breeding birds/hectare). According to data from Breeding Bird Surveys, counts of “Plain titmouse” are 13-15 times lower in piñon-juniper woodland compared to oak woodlands of California foothills (Cicero 2000). This information seems to match data from both the Carson’s avian surveys and surveys conducted by Eagle Environmental.

Two Breeding Bird Survey routes have been used to evaluate trend on the Carson National Forest. Both the Cebolla (near La Placitas) and Ojo Sarco routes are located on the Forest. The juniper titmouse was regularly detected on the Ojo Sarco route from 1968 to 2007, but was detected less frequently on the Cebolla route from 1973 to 2007, which is primarily along riparian habitat. The Ojo Sarco route shows a declining trend (Sauer et al. 2008). This data does document that the species regularly occurs on the Carson National Forest. Individual route trend estimates are seen in the table below.

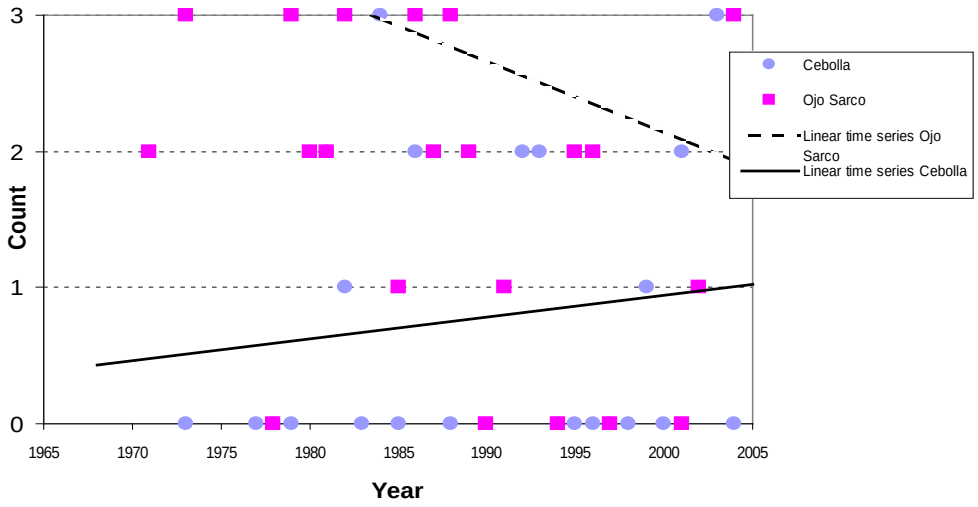


Figure 3. Time Series of Juniper Titmouse Data for Ojo Sarco and Cebolla Survey Routes

Analyzing population change on survey routes is probably the most effective use of BBS data, however these data do not provide an explanation for the causes of population trends (Sauer et al. 2008).

Table 3. Breeding Bird Survey Estimates for Juniper Titmouse

BBS Route	Trend Estimate Through 2000	Trend Estimate Through 2004	Trend Estimate Through 2007	Number of Years	Average Count
Cebolla	-40.13	-20.12	-26.88	26	0.69
Ojo Sarco	-3.40	-3.47	-3.30	39	2.92

The removal of piñon and juniper trees in large blocks was likely related to a decrease in juniper titmouse populations in the past. Breeding bird surveys show that a significant decline (-15.9%) of the juniper titmouse in New Mexico occurred between 1966 and 1979 (Sauer et al. 2008). This was likely due to the large areas of piñon-juniper that were type converted to grasslands throughout the Southwest during that period. More recent surveys show that from 1980 through 2007 the decline in population has decreased to -1.7 percent. As more piñon and juniper trees reestablish into the man-made grasslands, habitat for the juniper titmouse should trend towards stabilization unless offset by the natural mortality from the bark-beetle infestation.

Although the trend from one of the two survey routes on the Forest indicates a declining trend for the juniper titmouse, the cause(s) of this decline are unknown. This may be in part related to the existing dense stand conditions that may be reducing the forage base. Management activities impacting piñon-juniper, such as mechanical thinning and prescribed burning, would continue to reduce fuels and competition in the piñon-juniper and enhance the quality of the species' habitat. As long as snags and large trees are protected, thinning and burning would generate more understory grasses and forbs, which in turn would support more insects for a forage base. These management practices would also promote larger trees more quickly, providing better cavity opportunities for nesting.

While the overall population information for the juniper titmouse indicate a declining trend in juniper titmouse populations across their range, the forest-wide surveys seem to indicate that at this time the titmouse population seem to be on the low side, but holding at a stable level. This corresponds with the Carson Forest Plan's description of expected conditions for the titmouse over the life of the plan – "…titmouse populations may decrease over time in specific areas impacted by management activities, but populations will be maintained at levels greatly exceeding minimum viable populations" (USDA 1986c, p. 238).

REFERENCES

Beason, Jason; Giroir, Glenn. 2004. Monitoring the birds of Carson National Forest: 2003 Final Report. Revised February 2004. Brighton, CO: Rocky Mountain Bird Observatory. 73 p.

Beason, Jason; Leukering, Tony. 2005. Monitoring the birds of Carson National Forest: 2004 Final Report. Brighton, CO: Rocky Mountain Bird Observatory. 107 p.

Beason, J., K. Hutton, R. Sparks, A. Panjabi, and D. Hanni. 2006. Monitoring the Birds of Carson National Forest: 2005 Field Season Report. Tech. Rep. M-CNF05-01. Rocky Mountain Bird Observatory, Brighton, CO, 144 pp.

Beason, J., K. Hutton, R., J. Blakesley, A. Panjabi and D. Hanni. 2007. Monitoring the birds of the Carson National Forest: 2006 Field Report. Tech. Rep. M-CNF06-01. Rocky Mountain Bird Observatory, Brighton, CO, 88 pp.

Betancourt, J.L.; Pierson, E.A.; Rylander, K.A.; Fairchild-Parks, J.A.; Dean, J.S.1993. The influence of history and climate on New Mexico piñon-juniper woodlands. General Technical Report RM-236. Fort Collins, CO: US Department of Agriculture, Forest Service, Rocky Mountain Range and Experiment Station: 42-57.

Christman, B. J. 2001. Factors influencing pair territoriality in the juniper titmouse. Condor 103:361-369. 14 p.

Cicero, C. 2000. Oak titmouse (Baeolophus inornatus) and juniper titmouse (Baeolophus ridgwayi). *In* The Birds of North America, No. 485 (A. Poole and F. Gill, eds). The Birds of North America, Inc., Philadelphia, PA. 2 p.

Dahms, Cathy W.; Geils, Brian W., tech. Eds. 1997. An assessment of forest ecosystem health in the Southwest. General Technical Report RM-GTR-295. Fort Collins, CO: US Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 97 p.

Ehrlich, Paul; Dobkin, David; Wheye, Darryl. 1988. The birder's handbook: a field guide to the natural history of North American birds. New York, NY: Simon and Schuster, Inc.

Flippo, Mark. 1979. (unpubl.) Avian and rodent survey in the Jicarilla District of the Carson National Forest, New Mexico. 48 p.

Hubbard, J. 1970. Revised checklist of the birds of New Mexico. Publication No. 3. NM Ornithology Society.

LaGory, Kirk; Chang, Young-Shoo; Chun, K.C.; Reeves, Timothy; Liebich, Richard; Smith, Karen. 2001. A study of the effects of gas well compressor noise on breeding bird populations of the Rattlesnake Canyon Habitat Management Area, San Juan County, New Mexico. Report DOE/BC/W-31-109-ENG-38-10. Argonne National Laboratory. Argonne, IL. 51 p.

Laudenslayer, Jr., William; Balda, Russell. 1976. Breeding bird use of pinyon-juniper-ponderosa pine ecotone. Auk 93: 571-586. 15 p.

Miller, Richard; Tausch, Robin. 2002. The role of fire in juniper and pinyon woodlands: a descriptive analysis. Pages 15-30 in K.E.M. Galley and T.P. Wilson (eds.). Proceedings of the Invasive Species Workshop: the Role of Fire in the Control and Spread of Invasive Species. Fire Conference 2000: the First National Congress on Fire Ecology, Prevention, and Management. Miscellaneous Publication No. 11, Tall Timbers Research Station, Tallahassee, FL: 15-30.

NatureServe Explorer: An online encyclopedia of life [web application]. 2010. Version 7.1. Arlington, Virginia, USA: NatureServe. Available: http://www.natureserve.org/explorer. (Accessed: March 15, 2011).

New Mexico Partners in Flight. 2007. New Mexico Bird Conservation Plan Version 2.1.C. Rustay and S. Norris, compliers. Albuquerque, NM. 41 pages.

Pavlacky, David C.; Anderson, Stanley H. 2001. Habitat preferences of pinyon-juniper specialists near the limit of their geographic range. The Condor 2001 103: 322-331.

Sauer, J. R., J. E. Hines, and J. Fallon. 2008. The North American Breeding Bird Survey, Results and Analysis 1966 - 2007. Version 5.15.2008. USGS Patuxent Wildlife Research Center, Laurel, MD. Available: http://www.mbr-pwrc.usgs.gov/bbs/bbs.html. (Accessed: February 23, 2011).

Scott, Virgil E.; Evans, Keith E.; Patton, David R.; Stone, Charles P. 1977. Cavity-nesting birds of North American forests. Agriculture Handbook 511. Washington DC: US Department of Agriculture, Forest Service. 112 p.

Scott, Virgil E.; Patton, David R.; 1989. Cavity-nesting birds of Arizona and New Mexico forests. General Technical Report RM-10. Fort Collins, CO: US Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 72 p.

Stahlecker, Dale W.; Kennedy, Patricia L.; Cully, Anne C.; Kuykendall, Charles B. 1989. Breeding bird assemblages in the Rio Grande Wild and Scenic River Recreation Area, New Mexico. Southwestern Naturalist. 34(4): 487-498.

USDA Forest Service. 2006. Use of North American breeding bird surveys on region 3 national forest and grasslands with an annotated bibliography. Unpublished briefing paper by Ernest Taylor, Regional Biologist, Southwestern Region, Albuquerque, NM. 13 p.

U.S. Fish and Wildlife Service. 2008. Birds of Conservation Concern 2008. United States Department of Interior, Fish and Wildlife Service, Division of Migratory Bird Management,Arlington, Virginia. 85 pp. [Online version available at < http://www.fws.gov/migratorybirds/NewReportsPublications/SpecialTopics/BCC2008/BCC2008.pdf>]

Wright, H.A. 1990. Role of fire in the management of Southwestern ecosystems. Krammes, J.S., tech. coord. Effects of fire management of Southwestern natural resources; 1988 November 15-17; Tucson, AZ. General Technical Report RM-191. Fort Collins, CO: US Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 1-6.

Abert's Squirrel (*Sciurus aberti*)

INDICATOR SPECIES HABITAT

Abert's squirrel (also referred to as the tassel-eared squirrel) principally utilizes the ponderosa pine (*Pinus ponderosa*) forest type. The species is an indicator for the presence of interlocking canopies in ponderosa pine (USDA 1986a, p.97). Abert's squirrel depends on ponderosa pine for basically all its life necessities and requires diversity of age classes and tree densities (Dodd et al. 1998, Keith 2003). Pine twigs, pine cones, pine seeds, pine bark, as well as truffles (underground mushrooms known to form mycorrhizal associations with ponderosa pine) are used by the Abert's squirrel (Farentinos et al. 1981, States 1988). In addition to pure ponderosa pine stands, Abert's squirrels are also associated with Gambel oak (*Quercus gambelii*), true piñon pine (*Pinus edulis*), junipers (*Juniperus* spp.), quaking aspen (*Populus tremuloides*), and Douglas-fir (*Pseudotsuga menziesii*) (Keith 1965 and 2003) and have been documented in mixed conifer and spruce-fir forest in Arizona (Hutton et al. 2003). Findley and others (1975) mention that Abert's squirrels are common in mixed conifer canyons in New Mexico.

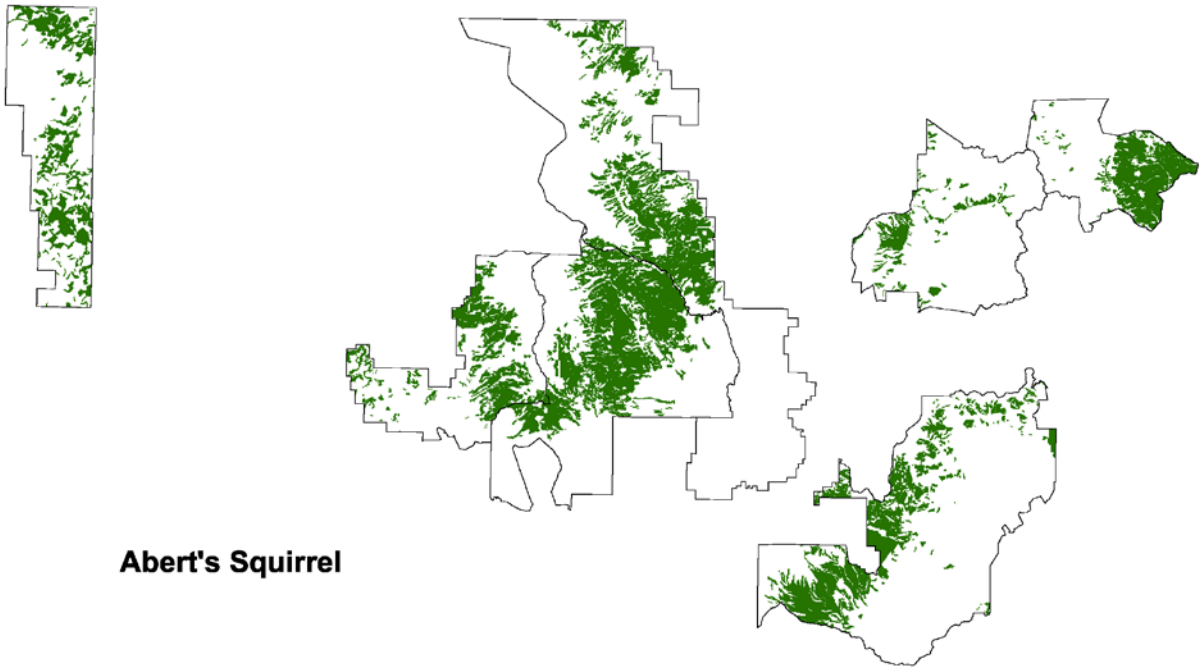
Tree density, diameter, and grouped distribution of trees are the most important components of Abert's squirrel nest cover. The right combinations of these factors provide squirrels with optimum conditions necessary for nest protection. The best cover conditions are found in uneven-aged ponderosa pine stands with trees spaced in small, even-aged groups within the stand. These pine stands have densities between 200 and 250 trees per acre. Average tree diameter for the stand is between 11 and 13 inches in diameter at breast height (DBH), but the presence of small groups of larger trees produces a mosaic of height groups (Patton 1975a). The majority of the use occurs in mid- to late seral stages or vegetation structural stage (VSS) classes 3 through 6. Dwarf mistletoe (*Arceuthobium vaginatum*) infestations that cause the formation of "witches brooms" are often incorporated into or support Abert's squirrel nests (Farentinos 1972).

Abert's squirrels are well distributed throughout the Southwest, but restricted to areas where ponderosa pine is the dominant tree (Patton 1975a). A good sign of squirrel activity is the presence of clipped twigs on the forest floor under ponderosa pine trees. The number of clipped twigs found has been suggested as a good index of Abert's squirrel population density. Large numbers of clippings cannot be present unless a sizable number of squirrels were available to make them (Brown 1982).

Potential Habitat Distribution

On the Carson National Forest, Abert's squirrel occurs sporadically throughout the ponderosa pine habitat type. The species may be casual in the piñon-juniper woodlands, mixed conifer and even spruce-fir (not shown on Map 1), but forest types other than ponderosa pine are not preferred habitat (Keith 1965, Patton and Green 1970, Patton 1975a, Pederson et al. 1976, Hall 1981, Pederson and Welch 1985).

The Carson Forest Plan estimates approximately 301,297 acres of ponderosa pine forest type that provides "potential" habitat for Abert's squirrel, based on vegetation coverage (USDA 1986c). These cumulative acres are generally referred to as "potential habitat" for the species. Map 1 displays the potential habitat for the Abert's squirrel, which is well distributed across the Forest (USDA 2003a).



Map 1. Abert's Squirrel Potential Habitat Distribution on the Carson National Forest

Management Activities or Natural Events That May Affect Habitat

Negative: Primarily related to long term cumulative effects of forest succession after heavy logging, long term fire suppression and some overstory removal prescriptions, wildfire and drought.

Positive: Thinning, harvest prescriptions that promote larger diameter trees while maintaining patches of interlocking canopy, prescribed fire and low intensity wildfire.

Plans, Regulations and Guidelines Supporting, Maintaining or Improving Habitat

- *Carson National Forest Land and Resource Management Plan, Forest-wide Prescriptions for Wildlife and Fish* (USDA 1986c) are described,

> By creating a diversity of stand conditions and providing juxtaposition of stands over time and space, suitable habitat components of Abert and red squirrels will be maintained over time. During the intensive reconnaissance phase of integrated stand management State and Federal biologists should identify those stands where squirrel activity is especially high and recommend deferment of cutting during the entry (USDA 1986c, p. Wildlife & Fish – 10).

  The desired conditions for Management Areas 4, 5 and 7 are described as quality habitat for Abert's squirrel (USDA 1986c, p. 4. Pine <40% - 1, p. 5. MC/PP >40% - 1, p. 7. Unsuitable - 1).

- *Record of Decision for Amendment of Forest Plans* (USDA 1996) provides guidelines relative to the management of both Mexican spotted owl and northern goshawk habitat.

Standards for ecosystem management in northern goshawk habitat include:

> Manage for old age trees such that as much old forest structure as possible is sustained over time across the landscape. Sustain a mosaic of vegetation densities (overstory and understory), age classes and species composition across the landscape. Provide foods and cover for goshawk prey (USDA 1996, p. 91).

- *Management Recommendations for the Northern Goshawk in the Southwestern United States* (Reynolds et al. 1992) describe the Abert's squirrel as an important prey species for the goshawk and habitat management recommendations include:
  - ✓ Ponderosa pine specialist
    - VSS 3, VSS 4, VSS 5, and VSS 6
  - ✓ Nesting
    - VSS 4, VSS 5, and VSS 6
    - Groups of trees with interlocking crowns are very important
  - ✓ Foraging (considered a food specialist)
    - VSS 3, VSS 4, VSS 5, and VSS 6
    - Large-diameter trees important for cone production
    - Areas of shaded overstory (>60%) necessary for fungi production
  - ✓ Other important habitat attributes
    - Snags may sometimes be used for nest trees
    - Downed logs and woody debris are important for food substrate and cover
    - Large openings are detrimental because they force squirrels, moving from tree to tree, to travel longer distances on the ground. Retention of trees with interlocking crowns may serve as travel ways and escape corridors.

HABITAT CONDITION AND TREND ON THE CARSON NATIONAL FOREST

There are two levels that need to be considered when looking at the ponderosa pine habitats across the Forest. First is the overall ponderosa pine habitat. This is important to help place the subset of interlocking canopies identified in the Forest Plan EIS in perspective. Although there are 301,297 total acres of ponderosa (based on current stand data cover types), the Forest Plan EIS identifies a subset of 53,220 acres of occupied (quality) Abert's squirrel habitat in the ponderosa pine. In 1986, when the Forest Plan was adopted, the key feature used to identify quality habitat was "interlocking canopies" (USDA 1986a, p. 97). Since that time, stands have grown, some have been harvested or burned, and data to estimate conditions has improved. Although there is important data forest-wide, the subset of interlocking canopies is the primary feature by which habitat trend for Abert's squirrel is tracked.

Patton (1984) determined habitat quality for the Abert's squirrel is a major density independent factor controlling squirrel populations. He states, "that habitat quality is a function of kinds, amounts, and distributions of food and cover; and that categories of habitat quality can be defined that will reflect the capability of a habitat to maintain a squirrel population." He also noted that habitat capability is expressed as potential, because high quality habitat may exist where squirrel populations are low due to weather, predators, disease, accidents, or geographic barriers to immigration.

Several factors are used to determine habitat trend. Management activities (primarily timber sales) and wildfire have reduced certain habitats to unsuitable conditions. High intensity wildfire

and certain harvest prescriptions such as overstory removal, seed cuts, and shelterwood harvests are examples of areas that are deducted from the total acres of interlocking canopies. Total stand acres are not deducted. Only the actual acres treated that are estimated to result in acres becoming unsuitable are subtracted. In an appendix, a management indicator species habitat trend analysis explains in more detail how habitat trend is determined.

Suitable stands (1,977 ac) that had experienced high intensity fire were removed from squirrel habitat. In addition, suitable habitat lost to timber harvest (2,604 ac) was deducted. Also taken into account is forest succession, where ponderosa pine stands have progressed towards more quality habitat since 1986. An estimate of stands moving to suitability from forest succession is five percent of the overall ponderosa pine on the Forest from 1986 to 2002 (see Appendix). Table 1 reflects the same rate of ingrowth through 2011.

The habitat trend for Abert's squirrel from 1986 to 2005 is estimated to have increased from 53,220 (per the 1986 Forest Plan) to 62,007 acres of interlocking canopies or an upward trend of almost 20 percent. From 2002 to 2005 there were no treatments that reduced squirrel habitat. Since 2005, there have been an estimated 500 acres per year of treatments.

Table 1. Abert's Squirrel Suitable Habitat Acres: Change from Wildfire, Logging, and Tree Growth 1986-2011

Ranger District	Total PP Acres	Estimated Acres of Habitat	Habitat Acres Reduced by Wildfire*	Habitat Acres Reduced by Logging	Total Acres Reduced	Total Acres of Ingrowth	Remaining Acres of Abert's Habitat
D1, D2, D6[1]	176,966	35,476	371	N/A	N/A	2,772	N/A
D3	33,905	6,729	22	N/A	N/A	526	N/A
D4	50,005	17,338	110	N/A	N/A	1,355	N/A
D7	40,421	5,001	1,474	N/A	N/A	391	N/A
Total	301,297	64,544	1,977	5,604	7,581	5,044	62,007

*Numbers for habitat acres reduced by wildfire are through 2007; N/A: Unavailable

[1] D1 = Canjilon, D2 = El Rito, D3 = Jicarilla, D4 = Camino Real, D6 = Tres Piedras, D7 = Questa

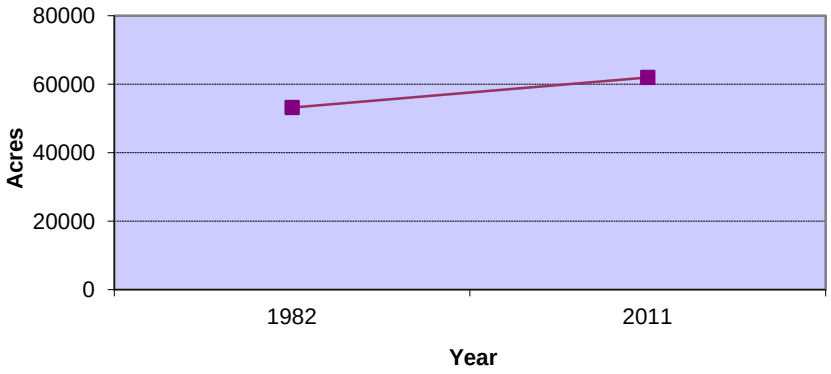


Figure 1. Changes in Abert's Squirrel Suitable Habitat on the Carson National Forest from 1986 to 2011.

Forest Management Activities

Management for quality Abert's squirrel habitat is management for large diameter, cone-producing ponderosa pines (Patton 1975a, Dodd et al. 1998, Halloran and Bekoff 1994; USDA 2002, Keith 2003). Optimum habitat for Abert's squirrels consists of stands of large ponderosa pine at densities greater than 200 trees per acre (Patton 1984; Keith 2003). Patton (1984) finds timber harvest in ponderosa pine stands is not incompatible with Abert's squirrel habitat management; however management goals should include maintenance of small, uneven-aged groups of large trees.

The recommended harvest type is group selection, with retention of ponderosa pine 15 to 20 inches DBH in groups suitable for nesting (Patton 1975a, Pederson et al. 1976, Patton 1984, Patton et al. 1985, Dodd et al. 1998, USDA 2002, Keith 2003). Pederson and others (1976) also recommended the following: established Abert's squirrel nesting and feeding sites should be avoided, harvesting should occur in late summer to early fall (after juveniles have left nests), logging units should be broken into small blocks and worked checkerboard fashion (to minimize direct disturbance of squirrels), and slash should not be piled and burned.

Some logging activities can degrade or remove Abert's squirrel habitat. Lower numbers of Abert's squirrels and lower recruitment rates occur in areas where large pines have been harvested than in unharvested areas. In Utah, Abert's squirrels fed less in logged ponderosa pine plots than in control plots. Abert's squirrels moved away from logged areas to unharvested stands. Plots had been logged with either a 10-inch or 12-inch minimum diameter cut (Pederson et al. 1976). Abert's squirrels consumed more hypogeous fungi in uncut stands than in logged stands. Fewer fungi were produced in logged stands, probably because crown reduction increased drying out of litter and decreased the amount of litter (Pederson et al. 1987). However, Patton and others (1985) note that squirrels moved away from timber harvesting activities, but later moved back into their home range.

While some studies show a dependence on fungi (Dodd et al. 1998, Pederson et al. 1987, States et al. 1988), other studies have shown a strong foraging response to pine cone production (Keith 1965, Pearson 1950, USDA 2005) by Abert's squirrel. Keith (2003) notes there is some confusion resulting from the conflicting findings in different studies. However, he states the studies are not contradictory, but results reflect differences in habitats and food availability in study areas. This makes it important to provide for a variety of available food across the landscape. Most food sources (phloem, mistletoe, truffles, apical buds, and

staminate cones) have similar caloric contents of about 5 kilocalories/gram, but pine seeds offer more energy (> 6.0 kilocalories/gram) and fungi somewhat less (<4.5 kilocalories/gram). Most foods are low in protein (<10 %), but pine seeds and mushrooms/truffles contain higher amounts of protein, 50 percent and 20 percent respectively (Keith 2003). Keith (2003) also notes squirrels have shown to increase their use of fungi in years when seed crops were low or absent and females take more high-energy foods in summer than males, but neither sex chose foods based only on their energy and protein content.

Large ponderosa pines with interlocking canopies are a structural component not as prevalent as desired across the Carson National Forest. The present dominance of mid-seral conditions in ponderosa pine relates primarily to cumulative effects of historic heavy harvesting, such as railroad logging early in the 20th century and fire suppression. Historic overstory removal prescriptions also contributed to the trend towards smaller diameter stands. The long-term trend (pre-forest plan) across the Carson was away from the larger structure stands and towards denser and smaller diameter stands. Some areas of ponderosa pine have also been lost or shifted towards mixed species by the invasion of white fir. However, during the life of the current Forest Plan the conditions for occupied habitat are estimated to have increased by about 20 percent. **As a result, the current habitat condition for this species is considered poor to fair (based on mid-seral dominance), but in an upward trend.**

Recent changes in management practices on the Forest places more emphasis on thinning and prescribed burning, which will increase desired Abert's squirrel habitat. Thinning to create clumpy conditions and reduce competition can make trees grow larger at a faster rate, than keeping stands dense. Prescribed burning controls dense reproduction of ponderosa pine stands. Maintenance of clustered stands is essential in providing the canopy cover needed for truffle production, as well as, cover and nesting sites (Patton 1975a, Dodd et al. 2003, Keith 2003). Reduction of stand heterogeneity and removal of big trees in large disjunctive blocks would likely have a negative effect on this squirrel's habitat (Keith 2003). In some areas there has been little or no activity in this habitat type during the life of the Forest Plan. For example, the Jicarilla Ranger District has not harvested commercial sawtimber since the 1970's, and incidental personal use in the ponderosa type is very limited.

Figure 2 shows between 1986 (when the Carson Forest Plan was implemented) and 2011 approximately 8 percent of potential Abert's squirrel habitat has been reduced by timber activities.

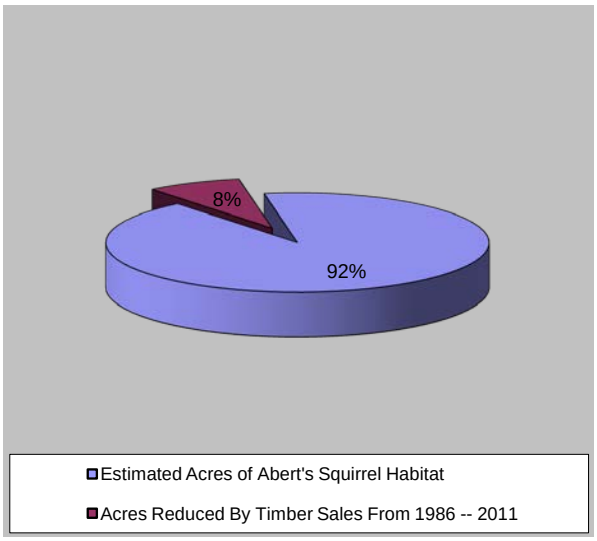


Figure 2. Proportion of Abert's Squirrel Habitat Reduced by Timber Sales on the Carson National Forest From 1986 to 2011

Unless 20 percent of an ecosystem management area has been allocated to old growth, Carson Forest Plan direction restricts harvesting large trees in the ponderosa pine in a manner that causes the stand to not meet old growth criteria (USDA 1996). More recent management has tended to focus on thinning from below, rather than timber activity primarily used during the early years of the Forest Plan. Management practices of thinning from below and group selections across the Forest enhance Abert's squirrel habitat that, in turn, should assure its survival (Patton 1984, Dodd et al. 1998).

Different thinning methods have been shown to affect Abert's squirrel use (Hope 2003, USDA 2004). Hope (2003) looked at six previously harvested units (4 thinned in 1996, 1 in 1997, and 1 between 1998 and 1999). The older thinning units (1996 and 1997) have limited sign of squirrel activity. The later thinned unit has abundant squirrel sign present in 2003. A good example of improving conditions for Abert's squirrel through thinning from below on the Carson is on the Questa Ranger District (USDA 2004). When surveying the project area prior to thinning, there was no evidence of use by Abert's squirrel. After treatment, monitoring demonstrated that squirrels from adjacent areas likely moved into the treated stands to take advantage of the improved foraging conditions.

POPULATION TREND

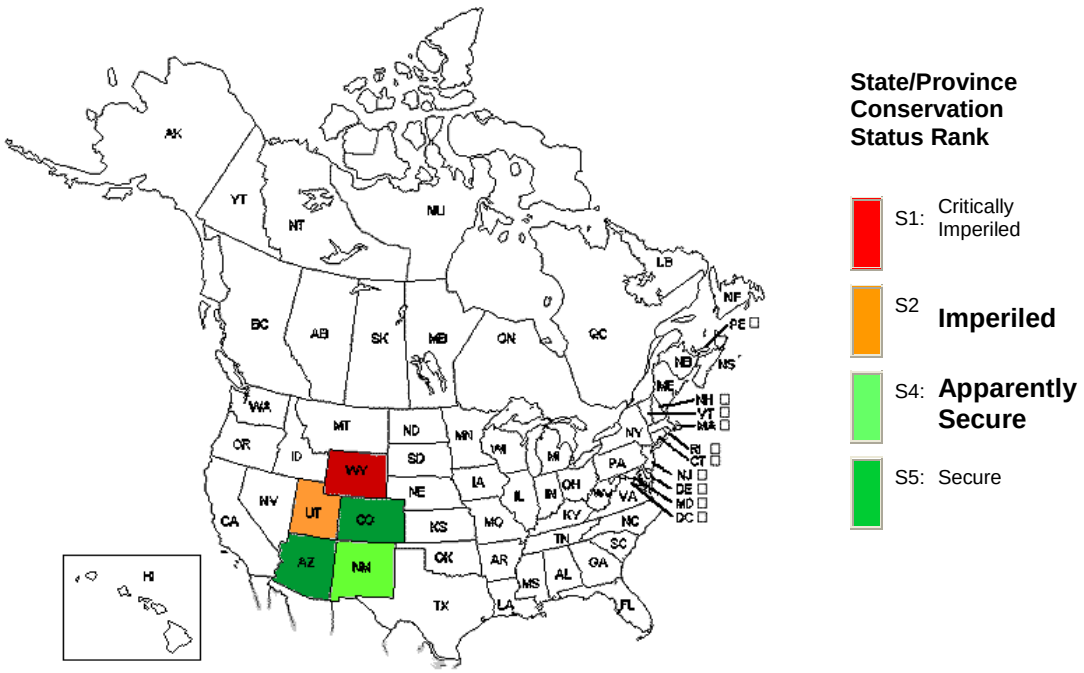
Information from the Bison-M database indicates that this species is fairly common throughout New Mexico and Arizona (NMDGF 2011). Findley (1975) also describes Abert's squirrel to be widely distributed throughout its range.

Regional

The NatureServe database (www.natureserve.org/explorer) documents that throughout its range, Abert's squirrel is listed as "G5", (i.e., globally secure and common, widespread and abundant). Reasons given for the G5 ranking are its large range and that it is common in many areas and there is no evidence of large-scale declines. It is not vulnerable in most of its range. Species with this rank typically occur in more than 100 localities, and there are more than 10,000 individuals. Within the United States, the Abert's squirrel is listed as "N5" (i.e., secure and common, widespread and abundant) (NatureServe 2010).

New Mexico

In New Mexico, the Abert's squirrel is listed as "S4" (i.e., apparently secure - uncommon but not rare, and usually widespread in the nation or state/province). An "S4" ranking can imply possible cause of long-term concern (NatureServe 2010). Several years ago on the Jicarilla Ranger District, the Abert's squirrel was determined to be plentiful enough for the New Mexico Department of Game and Fish to expand hunting of the species in the area.



Map 2. Distribution of Abert's Squirrel in North America (NatureServe Explorer 2010)

State wide harvest data indicates a slight decrease in mean harvest from 1983 to 1999 (NMDGF 2001). Population trends, however, are not necessarily directly correlated with harvest data. It is possible that the popularity of squirrel hunting is declining slightly. However, it is just as likely that some degree of correlation can be made. When populations are increasing, the popularity of squirrel hunting is likely to be more appealing. New Mexico's 2010-2011 hunting season has a bag limit of 8 squirrels per day, with 16 in possession (NMDGF 2010), which is the same bag limit since the 2004-2005 season. All of the Carson National Forest is open to squirrel hunting, except for the Valle Vidal unit, which is closed to all small mammal hunting.

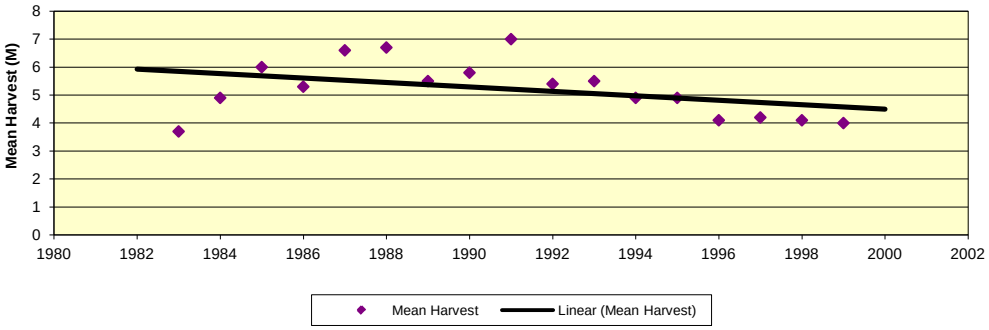


Figure 3. Mean Harvest Abert's Squirrel for New Mexico (NMDGF 2001)

Available evidence suggests populations of Abert's squirrels fluctuate both in the short- and long-term (Pearson 1950, Keith 1965, Keith 2003), but there is in no danger of extinction (UM 1997, Keith 2003). Population numbers of Abert's squirrels appear to fluctuate widely over time and space (Keith 2003, Patton 1984). Population cycles may be related to cyclic variation in the biomass of the pine seed crops. A good and widespread mast crop brings an abundance of squirrels, whereas a year or so of scanty pine cone production results in a scarcity of these animals.

Estimates of squirrel home range size vary as well. Patton (1975b) studied three squirrel home ranges in Arizona. The home range size varied between the squirrels (10 acres, 30 acres, and 85 acres). In Utah, Pederson and others (1976) radio-tracked squirrels during the summer on home ranges before and after timber harvests. Seven home ranges in this study averaged 6.2 acres before harvest, and three of these home ranges averaged 32.0 acres after harvest, indicating that timber harvesting can have an effect on squirrel density.

Optimum densities for excellent Arizona habitat are 50 to 100 per 100 acres (0.02 to 0.40/ha) (Patton 1977). More typical levels are 0.06 to 0.13 per hectare (Frey 2003 and 2004). However, Keith (2003) notes that other researchers have commented on the variations in Abert's squirrel numbers that are apparent over time and from area to area. Densities reported in different studies varies from 0.03 to 0.05/ha; 0.01 to 0.30/ha; 0.31 to 0.56/ha; 0.12 to 1.24/ha; 0.30 to 1.24/ha; and 2.47/ha (Keith 2003).

On the Carson National Forest, the Abert's squirrel ranges from fairly uncommon to common throughout the ponderosa pine type, but by no means approaches the more typical numbers found in Arizona. This is likely linked to the Forest having large areas of mid-seral habitat conditions as opposed to mature stands of ponderosa, coupled with less favorable (more extreme) weather conditions. It is unknown what a typical density number would be for the State of New Mexico in non-drought years. No studies have been conducted in the state or on the Forest since the drought in the Southwest started and when populations likely responded by decreasing in density. Frey (2003) does state, based on old feeding sign on the monitoring sites, "it is clear that during previous years Abert's squirrel had a greater distribution and abundance than observed in 2003."

Carson National Forest

There have been several publications, assessments, reports and inventories completed since the 2003 Forest-wide MIS Assessment (USDA 2003b) was completed for the Carson National Forest. Six years of inventory were completed on the Carson by Dr. Frey and reports have been prepared for 2003 - 2006 and 2008 - 2009 (Frey 2003, 2004, 2005, 2006, 2008, and 2009).

Generally these inventories indicate populations are at very low levels. While 2003 and 2004 both showed 0.005 squirrels/ha (1 squirrel/500 acres), the overall mean density has grown to 0.017 squirrels per hectare (1 squirrel/145 acres) in 2009 (Frey 2009, p. 15), a significantly higher density than in previous years. In addition, six new plots were added for the Valle Vidal in 2006 and these plots show mean density averages exceeding those for the rest of the survey area (1 squirrel per 99 acres) (Frey 2009). While the numbers are still low in comparison to other studies, they are similar to numbers found in Utah in 2003 and in the San Juan National Forest in 2004 (Frey 2009, p.24).

Table 2. Carson National Forest Survey Data (Mean Density/Acre) (Frey 2003-06 and 2008-09).

	2003	2004	2005	2006	2008	2009
Excl. Valle Vidal	.005/ha	.005/ha	0.010/ha	.012/ha	.017/ha	.017/ha
Valle Vidal				.065/ha	.032/ha	.025/ha

While comparing monitoring results on the Carson National Forest with other recent studies conducted in Arizona and Utah, two patterns are apparent to Dr. Frey (2005, p.24). First, it appears the entire region experienced declines in Abert's squirrel densities from 2001 to 2004. Second, the regional declines are probably attributable to drought conditions. In north-central New Mexico, drought conditions began in 2000 and extended into the beginning of 2004. In contrast with previous years, moisture was high during 2005; therefore, the increased density of Abert's squirrel on the Forest in 2005 is most likely due to increased moisture.

Dr. Frey (2005, p. 25) notes there may be several reasons why the Carson's surveys are lower than other studies conducted at the same time in adjacent states.

1. The surveys on the Carson are done using randomly selected ponderosa pine forest stands that may represent extreme variation in geography, topography, ecology and management conditions. There was no attempt to select ponderosa pine stands for their potential to harbor high Abert's squirrel populations. For example, some of the plots in the study were located at the lower, more arid edge of the ponderosa pine forest zone where it intergrades with piñon-juniper woodlands. Habitat analysis results indicate that the density of both piñon pine and juniper were associated with lower densities of Abert's squirrels.

   This is shown in the 2006 and 2008-09 data, when an additional six plots were included (for the Valle Vidal Unit) in ponderosa pine in or near the mixed-conifer interface. These plots were significantly higher than on the other plots with an average density of that varied between 1 squirrel per 35 acres and 1 squirrel per 99 acres (Frey 2009).

   In other studies, especially those designed to examine Abert's squirrel biology or response to specific forest treatments, the location of study areas may not have been random. Such studies would be more likely to utilize better developed ponderosa pine stands with the potential for higher Abert's squirrel densities in order to insure adequate sample sizes.
2. Climate conditions vary both temporally and spatially. Thus during a period of time when the Carson National Forest is experiencing drought, other areas within the range of Abert's may be experiencing periods of high moisture. Therefore, squirrel populations in different geographic regions may be influenced by different local climate and weather patterns.
3. Another potential reason for relatively low densities of Abert's squirrel might be attributable to spatial variation in topography. The potential for ponderosa pine forest development varies geographically throughout the Southwest. Ponderosa pine forests occur in a narrow elevational zone, with its best development typically between 7,544 and 8,692 feet

elevation. Ecologically, ponderosa pine forest generally occurs in a mid-elevation zone between the lower, more arid, piñon-juniper woodland zone and below the cooler, more mesic, mixed conifer forest zone. Large expanses of quality ponderosa pine forest habitat may be best developed in regions, such as the Mogollon Plateau, that have large areas of relatively flat terrain at optimal elevations. In contrast, much of the Carson National Forest consists of rugged mountains with steep terrain that function to compress the 7,500 to 8,700 foot contour into a relatively narrow band around the sides of mountains. This zonal compression puts Abert's populations in relatively close proximity to the piñon-juniper woodland zone, which they appear to avoid, and in relatively close proximity to mixed conifer forest, which is occupied by the aggressive and competitively dominant red squirrel (*Tamiasciurus hudsonicus*). Consequently, in areas of high topographic relief, Abert's squirrel populations may be relatively more constrained by factors such as area of available habitat, climate, and competition.

4. Densities numbers may be due to current habitat conditions as a result of past forest management (no active forest management has occurred on any of the plots during this study).

The current low population numbers are considered to be a result of: 1) drought conditions that severely impacted numbers during the period 2000-2004; 2) existing forest conditions from activities that occurred before implementation of the Carson Forest Plan (1986c); and 3) how the survey plots were determined. Treatments to move habitats towards a more desired condition for squirrels should not aggravate, contribute to, or result in a downward trend in population numbers. Furthermore, recent management decisions have focused on prescribed treatments that improve cone crop availability, which may also help with recruitment of squirrels in potential habitats. In addition, the Carson Forest Plan addresses management of squirrel habitat by stating, "During the intensive reconnaissance phase of integrated stand management, State and Federal biologists should identify those stands where squirrel activity is especially high and recommend deferment of cutting during the entry" (USDA 1986c, p. Wildlife & Fish – 10).

Stephenson and Brown (1980) estimate population declines resulting from heavy snow packs may take four years of moderate snow cover to recover from only two years of heavy snow pack. Drought reduces the availability of ponderosa pine cones and hypogenous fungi for the squirrel. However, it is not anticipated the wet conditions experienced on the Forest in late-summer 2005 will dramatically improve foraging conditions for the squirrel in 2006 and subsequently cause a rapid increase in numbers. Many stands in 2005 still did not have much pine cone production as it takes two years for pine cones to fully develop (Fruits, per comm. 2005). It is assumed it will take longer to recover from drought than two years of heavy snow fall, due to the time it takes ponderosa pine to start producing an abundant cone crop again.

Keith (2003) notes, "Abert's squirrel is a survivor and will persist as a species, although perhaps in reduced numbers" and "that the squirrel has shown the ability to thrive in sparse populations and to emigrate considerable distances to successfully establish new stable populations."

Populations for Abert's Squirrel on the Carson National Forest have increased from 2002 to 2011 and are approaching the low end of the range of optimum density found by Patton (1977). The Valle Vidal unit is an exception to the upward trend and shows declines from 2006-2009. With the exception of prescribed burning, Valle Vidal is largely an untreated area and the population trends there cannot be attributed to management treatments. As well, the data for Valle Vidal is insufficient to establish a credible trend (only three surveys points

exist) and the density for the unit exceeds both the minimum of the optimum density range and the average density for the remainder of the Carson.

Overall, this confirms what the Forest Plan predicts of squirrel populations over the course of plan implementation – "…populations are expected to increase because of improved habitat condition" (USDA 1986c, p. 238). It should be noted, since the implementation of the Forest Plan in 1986, 93 percent of Abert's squirrel habitat on the Forest has not been impacted by management activities and current habitat conditions are primarily the result of pre-forest plan related management and is not associated with how the Forest is managed today. Management activities designed to improve long-term habitat conditions should be a priority.

A noteworthy and consistent characteristic regarding parameters affecting Abert's squirrel demography is their variability. Keith (2003) sums up this variability:

> Food habits differ depending on the availability of foods. Home range varies with the quality of squirrel habitat and the weather. Frequency of breeding, breeding success, and population mortality are all influenced by the weather, which is the most variable and perhaps influential factor of all. Finally, the temporal or spatial abundance of squirrels is determined by the interaction of natality, mortality, and habitat quality. As a result, squirrel numbers vary considerably both spatially and temporally.

REFERENCES

Brown, D.E. (ed.) 1982. Biotic communities of the American Southwest - United States and Mexico. Volume 4, Numbers 1-4. Superior, AZ: University of Arizona. 342 p.

Davis, Russell; Bissell, Steven J. 1989. Distribution of Abert's squirrel (*Sciurus aberti*) in Colorado:evidence for a recent expansion of range. The Southwestern Naturalist. 34(2): 306-309.

Dodd, Norris L. 1996. Taking tassel-eared squirrel management into the 21st century, a research status report. Wildlife Views. November 1996: 1-12.

Dodd, Norris L.; Rosenstock, S. S.; Miller, C. R.; Schweinburg, R. E. 1998. Tassel-eared squirrel population dynamics in Arizona: index techniques and relationships to habitat condition. Arizona Game and Fish Department, Research Branch Technical Report, 27:1-49.

Dodd, Norris L. 2003. Landscape-scale habitat relationships to tassel-eared squirrel population dynamics in north-central Arizona. Arizona Game and Fish Department Technical Guidance Bulletin No. 6, Phoenix, Arizona. 28 p.

Dodd, N.L.; States, J.S.; Rosenstock, S.S. 2003. Tassel-eared squirrel population, habitat condition, and dietary relationships in North-Central Arizona. Journal of Wildlife Management 67(3):622-533.

Farentinos, R.C. 1972. Nests of the tassel-eared squirrel. Journal of Mammalogy. 53(4): 900-903.

Farentinos, R.C.; Capretta, P.J.; Kepner, R.E.; Littlefield, V.M. 1981. Selective herbivory in tassel-eared squirrels: role of monoterpenes in ponderosa pines chosen as feeding trees. Science. 213(11) September 1981: 1273-1275.

Ffolliott, Peter F.; Patton, David R. 1975. Production-rating functions for Abert squirrels in southwestern ponderosa pine. Wildlife Society Bulletin. Winter 1975. 3(4):162-165.

Ffolliott, Peter F.; Patton, David R. 1978. Abert squirrel use of ponderosa pine as feed trees. Res. Note RM-362. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 4 p. [18449]

Findley, J.A.; Harris A.H.; Wilson, D.E.; Jones, C. 1975. Mammals of New Mexico. Albuquerque, NM: Univ. of New Mexico Press: xxii + 360 p.

Flyger, Vagn; Gates, J. Edward. 1982. Pine squirrels (*Tamiasciurus hudsonicus* and T. *douglasii*). *In* Rodentia. Johns Hopkins University Press: 230-238.

Frey, J. 2003. Initiation of Abert's squirrel (*Sciurus aberti*) monitoring on Carson National Forest, New Mexico. A Final Contract Report R3-02-03-12 Completion Report. Carson National Forest, December, 31 2003. 18 p.

Frey, J. 2004. Abert's squirrel (Sciurus aberti) monitoring and habitat analysis on Carson National Forest, New Mexico. A Final Contract Report R3-83A7-4-0038 Completion Report. Carson National Forest, December 9, 2004. 21p.

Frey, J. 2005. Abert's squirrel (Sciurus aberti) monitoring on Carson National Forest, New Mexico, 2005. Final Contract Report AG-83A7-P-05-0002 Completion Report. Carson National Forest. December 6, 2005. 32 p.

Frey, J. 2006. Abert's squirrel (Sciurus aberti) Monitoring on Carson National Forest, New Mexico, 2006. Final Contract Report AG-83A7-P-06-0023 Completion Report. Carson National Forest. November 30, 2006. 41 p.

Garnett, Gregg; Mathiasen, Robert; Chambers, Carol. 2004. A comparison of wildlife use in broomed and unbroomed ponderosa pine trees in northern Arizona. Western Journal of Applied Forestry. 19(1): 42-46.

Hall, Joseph. 1967. White tails and yellow pines. National Parks Magazine. April 1967. 3 p.

Halloran, M.E.; Bekoff, M. 1994. Nesting behavior of Abert squirrels (*Sciurus aberti*). Ethology 97: 236-248.

Hope, Andrew. 2003. Abert's Squirrel (*Sciurus aberti*) surveys in four fuel-wood thinning units with the Camino Real Ranger District of the Carson National Forest, NM. Unpublished. 7 p.

Hutton, Kelly A; Koprowski, John L; Greer, Vicki L; Alanen, Marit I; Schauffert, Carol A.; Young, Paul J. 2003. Use of mixed-conifer and spruce fir forests by an introduced population of Abert's squirrels (*Sciurus aberti*). The Southwestern Naturalist 48(2): 257-260.

Keith, James O. 1965. The Abert squirrel and its dependence on ponderosa pine. Ecology. 46: 150-163.

Keith, James O. 2003. Abert's squirrel (S*ciurus aberti)*: a technical conservation assessment. [Online]. USDA Forest Service, Rocky Mountain Region. August 25, 2003. Available: http://www.fs.fed.us/r2/projects/scp/assessments/abertsquirrel.pdf

Murphy, Shannon; Linhart, Yan. 1999. Comparative morphology of the gastrointestinal tract in the feeding specialist *Sciurus aberti* and several generalist congeners. Journal of Mammology. 80(4):1325-1330.

NatureServe Explorer: An online encyclopedia of life [web application]. 2010. Version 7.1. Arlington, Virginia, USA: NatureServe. Available: http://www.natureserve.org/explorer. (Accessed: March 15, 2011).

New Mexico Department of Game and Fish. 2001. Analysis of New Mexico Department of Game and Fish small game harvest surveys of 1999-2000. Professional Service Contract No. 01-516.35. Santa Fe, NM: Chaparral Systems Corporation.

New Mexico Department of Game and Fish. 2010. New Mexico small game and waterfowl rules and information. [Online version available at http://wildlife.state.nm.us/publications/documents/rib/2010/10_11_SmallGameRIB_8_13.pdf]

New Mexico Department of Game and Fish. 2011. BISON-M (Biota Information System of New Mexico): Biological database for New Mexico. NMDGF in cooperation with USDI BLM, USDI FWS, USDI Bureau of Reclamation, US Army Corps of Engineers, USDA Forest Service and University of New Mexico. http://www.bison-m.org. (Accessed: March 23, 2011)

Patton, David. 1974a. Characteristics of ponderosa pine stands selected by the Abert's squirrel for cover. A dissertation submitted to Dept. of Watershed Mgmt. University of Arizona. 1974. 40 p.

Patton, David. 1974b. Estimating food consumption from twigs clipped by the Abert squirrel. Research Note RM-272. Fort Collins, CO: US Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 3 p.

Patton, David R. 1975a. Abert's squirrel cover requirements in southwestern ponderosa pine. Research Paper RM-145. Fort Collins, CO: US Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 12 p.

Patton, David R. 1975b. Nest use and home range of three Abert's squirrels as determined by radio tracking. Research Paper RM-281. Fort Collins, CO: US Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. February 1975. 3 p.

Patton, David R. 1977. Managing southwestern ponderosa pine for the Abert squirrel. Journal of Forestry. 75: 264-267.

Patton, David R. 1984. A model to evaluate abert squirrel habitat in uneven-aged ponderosa pine. Wildlife Society Bulletin. 12: 408-414.

Patton, David R.; Green, Win. 1970. Abert's squirrels prefer mature ponderosa pine. Research Note RM-169. Fort Collins, CO: US Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experimental Station. 3 p.

Patton, David; Wadleigh, Richard; Hudak, Howard. 1985. The effects of timber harvesting on the Kaibab squirrel. Journal of Wildlife Management. 49(1): 14-19.

Pearson, G.A. 1950. Management of ponderosa pine in the southwest as developed by research and experimental practices. Washington DC: US Department of Agriculture. Monograph 6. 216 p.

Pederson, Jordan C.; Farentinos, R.C.; Littlefield, Victoria M. 1987. Effects of logging on habitat quality and feeding patterns of Abert squirrels. The Great Basin Naturalist. 47(2): 252-258. [6904]

Pederson, Jordan C.; Hasenyager, R.N.; Heggen, A.W. 1976. Habitat requirements of the Abert squirrel (S*. aberti navajo*) on the Monticello district, Manti-Lasal National Forest of Utah. Publication Number 76-9, Utah State Division of Wildlife Resources.

Pederson, Jordan C.; Welch, B.L. 1985. Comparison of ponderosa pine as feed and nonfeed trees for Abert squirrels. Journal of Chemistry Ecology. 11: 149-157.

Rasmussen, Irvin; Brown, David; Jones, Dale. 1975. Use of ponderosa pine by tassel-eared squirrels and a key to determine evidence of their use from that of red squirrels and

porcupines. Wildlife Digest. Abstract 10, October 10, 1975. Arizona Game and Fish Dept. 12 p.

Raught, Richard. 1967. Tree squirrels. *In* New Mexico Wildlife Management: 95-100.

Reynolds, Hudson g. 1966. Abert's squirrels feeding on pinyon pine. Journal of Mammology. 47(3): 550.

Reynolds, Richard T.; Graham, Russell T.; Reiser, M. Hildegard; and others. 1992. Management recommendations for the northern goshawk in the southwestern United States. General Technical Report RM-217. Fort Collins, CO: US Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 90 p.

Smith, Jane Kapler, ed. 2000. Wildland fire in ecosystems: effects of fire on fauna. General Technical Report RMRS-GTR-42-vol. 1. Ogden, UT: US Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 83 p.

States, Jack S.; Gaud, William S. 1997. Ecology of hypogenous fungi associated with ponderosa pine: patterns of distribution and sporocarp production in some Arizona forests. Mycologia. 89(5): 712-721.

States, Jack S.; Gaud, William S.; Allred, W. Sylvester; Austin, William J. 1988. Foraging patterns of tassel-eared squirrels in selected ponderosa pine stands. In Szaro, R.; Severson, K.; Patton, D.; eds. Management of amphibians, reptiles and small mammals in North America. Proceedings of a symposium, General Technical Report RM-166. Fort Collins, CO; US Department of Agriculture, Forest Service, Rocky Mountain Range and Research Station: 425-43.

Stephenson, Richard L.; Brown, David E. 1980. Snow cover as a factor influencing mortality of Abert's squirrels. Journal of Wildlife Management. 44 (4): 951-955.

USDA Forest Service. 1996. Record of decision for amendment of forest plans – Arizona and New Mexico. Albuquerque, NM: US Department of Agriculture, Forest Service, Southwestern Region. 96 p.

USDA Forest Service. 2002. Fire Effects Information System, [Online]. Available: http://www.fs.fed.us/database/feis/. Fort Collins, CO: US Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory.

USDA Forest Service. 2004. An example of where thinning from below can improve habitat for Abert's squirrel: unpublished monitoring report by Charles Kuykendall, Wildlife Biologist, Carson National Forest. November 2, 2004. 3 p.

USDA Forest Service. 2005. Trip to Aqua/Caballos analysis area: unpublished monitoring report by Jack Carpenter, Carson National Forest. May 26, 2005. 5 p.

University of Michigan. 1997. Animal diversity web (animaldiversity.ummz.umich.edu). Ann Arbor, MI. Page last updated 05 December 1997. (Accessed on April 4, 2005)

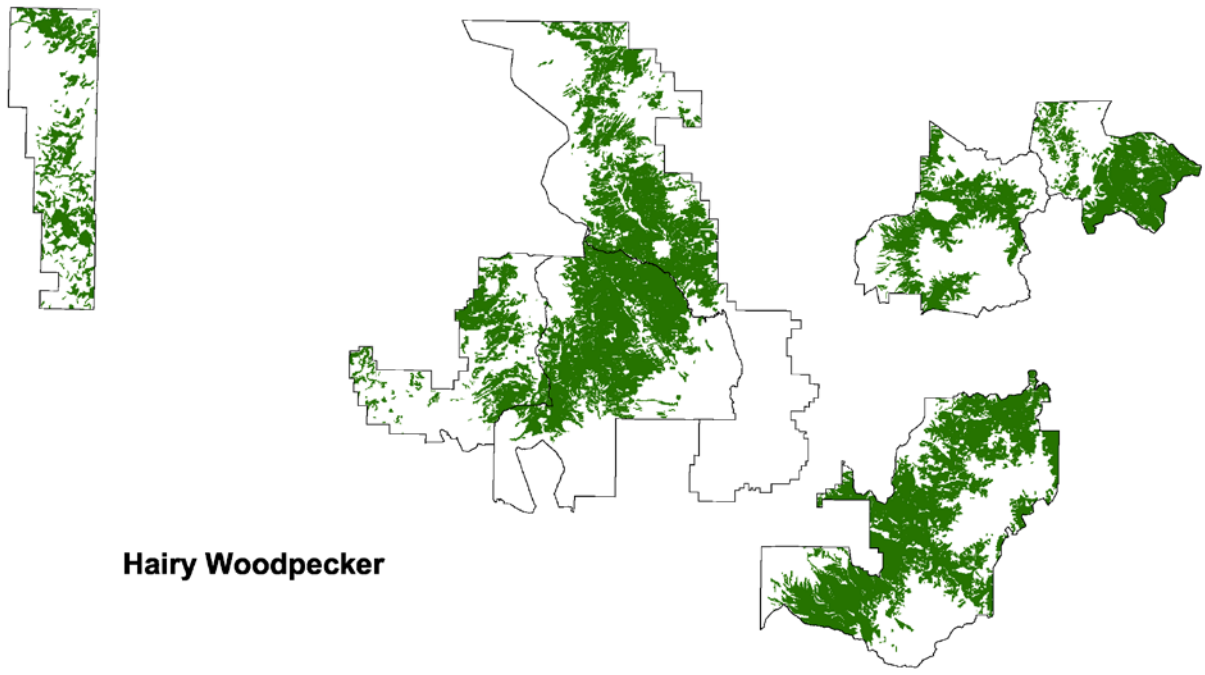
Hairy Woodpecker (*Picoides villosus*)

INDICATOR SPECIES HABITAT

The hairy woodpecker is an indicator species for the presence of snags (USDA 1986a, p.97). Hairy woodpeckers are one of the most common woodpeckers in the Southwest, particularly in riparian habitats and in ponderosa pine, mixed-species and spruce-fir forests (NMDGF 2011). The species is a forest generalist, keying in on available snags and live aspen. Nests are primarily in trees averaging 17 inches in diameter at breast height (DBH) and approximately 60 feet high. The woodpecker forages for insects primarily on tree trunks averaging 17 inches DBH and greater than 30 feet tall. Down logs are also important in supporting insect populations for the hairy woodpecker.

Potential Habitat Distribution

On the Carson National Forest, this species is commonly observed throughout the ponderosa pine, mixed conifer, and aspen habitat types. The species may be casual in the spruce-fir (not shown on map), but higher elevations are not preferred habitat. Based on Geographic Information System (GIS) vegetation cover data from Terrestrial Ecosystem Survey (USDA 1987), the Carson National Forest supports approximately 839,248 acres of potential habitat. The potential habitat for the hairy woodpecker is abundant and well distributed across the Forest.



Map 1. Hairy Woodpecker Potential Habitat Distribution on the Carson National Forest (USDA 1987)

Management Activities or Natural Events That May Affect Habitat

Negative: Excessive gathering of dead and down fuelwood, reducing fuel loads by prescribed fire and wildfire across large areas (Frissell 1984). Thinning in the wildland urban interface (WUI) could reduce fuels that provide habitat.

Positive: Maintaining large trees for future down logs and snags, maintaining standing dead aspen and cottonwood trees, reducing open road densities in areas of highly accessible dead and down material, wildfires and insect and disease infestations.

Plans, Regulations and Guidelines Supporting, Maintaining or Improving Habitat

- *Carson National Forest Land and Resource Management Plan, Forest-wide Wildlife and Fish* (USDA 1986c) requires that "at least 300 snags per 100 acres on 60 percent of suitable timberlands be retained, not determined by interdisciplinary team review to be highly vulnerable to fuelwood collection. The guideline for the minimum size for snags is: Conifers - 12 inch DBH and 15 feet tall. Aspen - 10 inch DBH and 12 feet tall." (USDA 1986c, p. Wildlife & Fish – 8)

  The Forest Plan's direction on down logs is to "retain sufficient size and length per 100 acres of down logs (where biologically feasible) on 75 percent of suitable timberlands, not determined by interdisciplinary team review to be highly vulnerable to fuelwood collection. The guideline for the minimum size for down logs is: Conifers - 12 inch diameter and 5000 linear feet per 100 acres of mixed conifer, ponderosa pine and spruce-fir. Aspen - 10 inch diameter and 3300 linear feet per 100 acres." (USDA 1986c, p. Wildlife & Fish –9)

  The desired conditions for Management Areas 1 through 7 are described as quality habitat for hairy woodpecker (USDA 1986c, Management Area Prescriptions for MA 1 through 7).

- *Record of Decision for Amendment of Forest Plans* (USDA 1996) provides guidelines relative to the management of both Mexican spotted owl and northern goshawk habitat. In restricted areas "retain substantive amounts of key habitat components:

  - ✓ Snags 18 inches in diameter and larger.
  - ✓ Down logs over 12 inches midpoint diameter (USDA 1996, p. 90).

  In goshawk landscapes outside of post-fledging family areas "snags are 18 inches or larger DBH and 30 feet or larger in height, downed logs are 12 inches in diameter and at least 8 feet long, woody debris 3 inches or larger on the forest floor, canopy cover is measured with vertical crown projection on average across the landscape." (USDA 1996, p. 92)

- *Management Recommendations for the Northern Goshawk in the Southwestern United States* (Reynolds et al. 1992) describe the hairy woodpecker as an important prey species for the goshawk and habitat management recommendations include: "Snag availability in managed stands can be increased by:

  - ✓ Leaving snags during timber harvest, and
  - ✓ Creating snags using herbicides, topping, or girdling" (Reynolds et. al 1992).

- *Mexican Spotted Owl Recovery Plan* (1995) also references the importance of snag and down log retention for Mexican spotted owl prey species (USDI 1995).

HABITAT CONDITION AND TREND ON THE CARSON NATIONAL FOREST

The key feature used in the Carson Plan Environmental Impact Statement (EIS) to identify quality hairy woodpecker habitat was "snags" (USDA 1986a, p. 97). There are two levels that need to be considered when looking at hairy woodpecker habitat across the Forest. According

to the Forest Plan EIS, hairy woodpeckers will utilize mature and old growth stands of pine, fir, and aspen (USDA 1986a, p. 97). So the first level considered is the overall ponderosa pine, spruce-fir, mixed conifer, and aspen habitat. This is important to help place the subset of quality habitat in perspective. Although there are approximately 839,248 total acres of potential habitat (as determined by the Terrestrial Ecosystem Survey completed in 1987), the Forest Plan EIS identifies a subset of 112,701 acres of suitable habitat in the forest. Since 1986, stands have grown, some have been harvested or burned and data to estimate conditions has improved. Although this is important data forest-wide, the subset of snags is the primary feature by which habitat trend for hairy woodpecker is tracked.

Several factors are used to determine habitat trend. Management activities (primarily timber sales) and wildfire have reduced certain habitats to unsuitable conditions. High intensity wildfire and certain harvest prescriptions such as overstory removal, seed cuts, and shelterwood harvests are examples of areas that are deducted from the total acres of quality hairy woodpecker habitat. Total stand acres are not deducted. Only the actual acres treated that are estimated to result in acres becoming unsuitable are subtracted. In an appendix, a management indicator species habitat trend analysis explains in more detail how habitat trend is determined.

Suitable stands (500 ac) that had experienced high intensity fire were removed from the woodpecker habitat. Suitable habitat lost to timber harvest (4,484 ac) was also deducted. Also taken into account is forest succession, where ponderosa pine stands have progressed towards more quality habitat since 1986. Only a one percent ingrowth rate was used from 1986 to 2002 (see Appendix) as the dense nature of many of the stands result in significant competition and stagnation in those stands that would most likely progress to old growth.

The rate of ingrowth for the period 2002-2011 has increased to five percent. The forest silviculturist estimates a 500% increase in snags in mixed conifer habitat over the period 2002-2008 as a result of a beetle infestation in this habitat. Mixed conifer represents nearly 30% of the hairy woodpecker potential habitat and the forest silviculturist further estimates that nearly 100% of this habitat fit the description of quality habitat after the beetle infestation (Fruits pers. comm. 2011); so five percent represents a conservative estimate of the rate of ingrowth for 2002-2011. Table 1 reflects the rate of ingrowth through 2011.

Table 1. Hairy Woodpecker Suitable Habitat Acres: Change from Wildfire, Logging, and Tree Growth 1986-2011

Ranger District	Total Acres	Estimated Acres of Suitable Habitat	Habitat Acres Reduced by Wildfire*	Habitat Acres Reduced by Logging	Total Acres Reduced	Total Acres of Ingrowth	Remaining Acres of Hairy Woodpecker Habitat
D1, D2, D6[1]	342,426	33,140	0	N/A	N/A	1263	N/A
D3	35,848	341	0	N/A	N/A	13	N/A
D4	254,306	54,020	0	N/A	N/A	2060	N/A
D7	206,668	25,200	500	N/A	N/A	961	N/A
Total	**839,248**	**112,701**	**500**	**4,484**	**4,984**	**4,297**	**112,014**

*Numbers for habitat acres reduced by wildfire are through 2007; N/A: Unavailable

[1] D1 = Canjilon, D2 = El Rito, D3 = Jicarilla, D4 = Camino Real, D6 = Tres Piedras, D7 = Questa

The recent estimates of harvest treatments for ponderosa pine and mixed conifer habitats are 500 acres/year and 100 acres/year respectively for the period 2005-2011. **From 1986 to 2011, the estimated habitat trend for hairy woodpecker on the Carson National Forest is from 106,880 acres (per the 1986 Forest Plan) to 112,014 acres of habitat, or an upward trend of 5 percent.** It should be noted that these numbers reflect acres of the best condition habitats and are most comparable to the acres estimated at the time the Forest Plan was initiated. An appendix to this document explains the method and rationale for this determination.

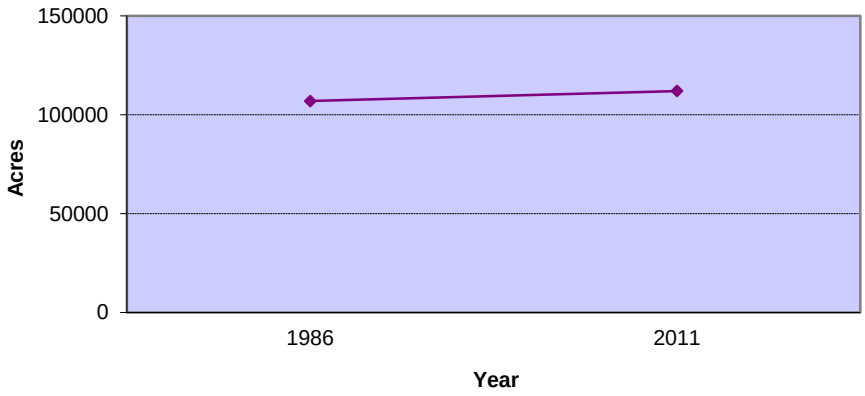


Figure 1. Changes in Hairy Woodpecker Suitable Habitat on the Carson National Forest 1986-2011

Forest Management Activities

Forest-wide conditions are represented by various diversity unit analyses that have been conducted since the inception of the Forest Plan (1986). These include analyses such as MaPa, Alamo/Dinner, Angostura, and Ojo Ryan on the east side of the Carson. On the west side these include: Hopewell, Felipito, La Manga, Borracho, Valle Grande, Upper Petaca Ecosystem Management Area, as well as, data from the entire Vallecitos Federal Sustained Yield Unit and other stand exams across the Forest. These are generally consistent with conditions on most of the Forest, except that the domination of mid-seral conditions (VSS 3 and 4) appears to be even more prevalent on the east side than the west. With the exception of wilderness areas, early (VSS 1) and late (VSS 6) seral conditions are largely absent.

Snags comprise an important habitat component for many woodpeckers and other cavity-nesting species. Low snag availability resulting from timber harvest, fuelwood removal, or intense surface fires may adversely affect populations of snag-dependent species, such as the hairy woodpecker (Balda 1975 and Thomas et al. 1979). Figure 2 shows that between 1986 (when the Carson Forest Plan was implemented) and 2005; approximately four percent of potential hairy woodpecker habitat has been reduced by timber activities.

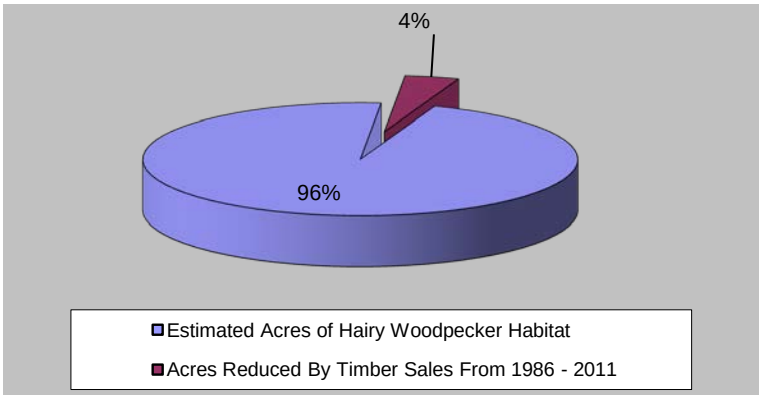


Figure 2. Proportion of Hairy Woodpecker Habitat Reduced by Timber Sales on the Carson National Forest from 1986 to 2011 (RMRIS DB, Activity Records)

Gathering of dead and down fuelwood is common practice on the Carson National Forest. Accessibility and increasing demand for fuelwood has made snags susceptible to removal along forest roads. Areas with high road density have the highest rate of snag removal -- primarily on slopes immediately above roads. Zones generally confined to 50 feet on either side of an open road are where fuelwood gathering is most concentrated. Dead and down fuelwood gathering requires a permit. The *Carson Firewood Guide* (USDA 2005), which accompanies every fuelwood permit issued, specifically states, "You may not cut:

- ✓ Standing dead ponderosa pine trees or those to be preserved for wildlife habitat.
- ✓ On timber sale or contract areas posted with signs, green fuelwood areas.
- ✓ Within 100 feet of paved roads.
- ✓ Within 100 feet of lakes and flowing streams.
- ✓ Within established recreation areas."

There are over 254,000 acres of wilderness areas (Wilderness Act 1964), wild and scenic river areas (Wild and Scenic Rivers Act 1968), roadless areas (USDA 1986c, 20. Semi-primitive-2), slopes > 40 percent (USDA, 5. MC/PP >40% - 2 and Timber – 12) and special management areas (USDA 1986c, 19. Special Areas – 2) on the Carson National Forest that have management direction through the Forest Plan or federal laws that exclude harvesting or removal of snags or are considered inaccessible to snag removal.

In addition, management efforts since 1986 have been consistent with Forest Plan guidelines, which are intended to "provide quality habitat for the hairy woodpecker." Large trees, which are future down logs and snags, are being maintained across the Forest.

Natural Snag Recruitment

Wildland fire and insect and disease infestations result in the creation of snags. Approximately 6,000 acres of snags of various species in ponderosa pine and mixed conifer vegetation type were created in the 1996 Hondo Fire event on the Questa Ranger District. Such variations are considered relatively temporary. Other than the Hondo Fire, very few fires - wild or prescribed - have actually changed seral stage conditions on the Carson.

Since 1979, insect infestations have been tracked on the Carson National Forest through aerial surveys. The cumulative insect and disease infestations that have occurred from 1979 to 2001 have been mapped. Depending on the type of insect attack, snags are created at different rates as a natural part of ecosystem processes. Pine bark beetle occurrences almost always result in

small pockets of ponderosa pine tree mortality after one year. The trend in bark beetle infestations on the Forest since 1986 directly correlates to snag recruitment and improvement of habitat for the hairy woodpecker.

Spruce budworm infestations generally slow growth unless repeated defoliation occurs over several years. The spruce budworm infestations usually move around to different areas, but overlap areas do occur and those areas generally produce some snags after several years.

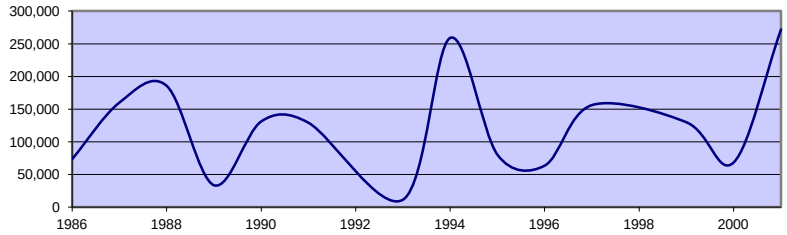


Figure 3. Spruce Budworm Defoliation on Carson National Forest 1985 to 2001 (acres).

During the life of the Carson Forest Plan, there has been little change in the long-term trend of available habitat and quality of habitat. This conclusion can be made given 1) the small amount of potential hairy woodpecker habitat that has been affected by forest management activities since 1986, 2) the relatively minor changes in seral conditions due to wildfire, 3) the limited areas on the Forest where dead and down fuelwood is collected, and 4) the continuation of natural snag recruitment, which compensates for items 1-3.

POPULATION TREND

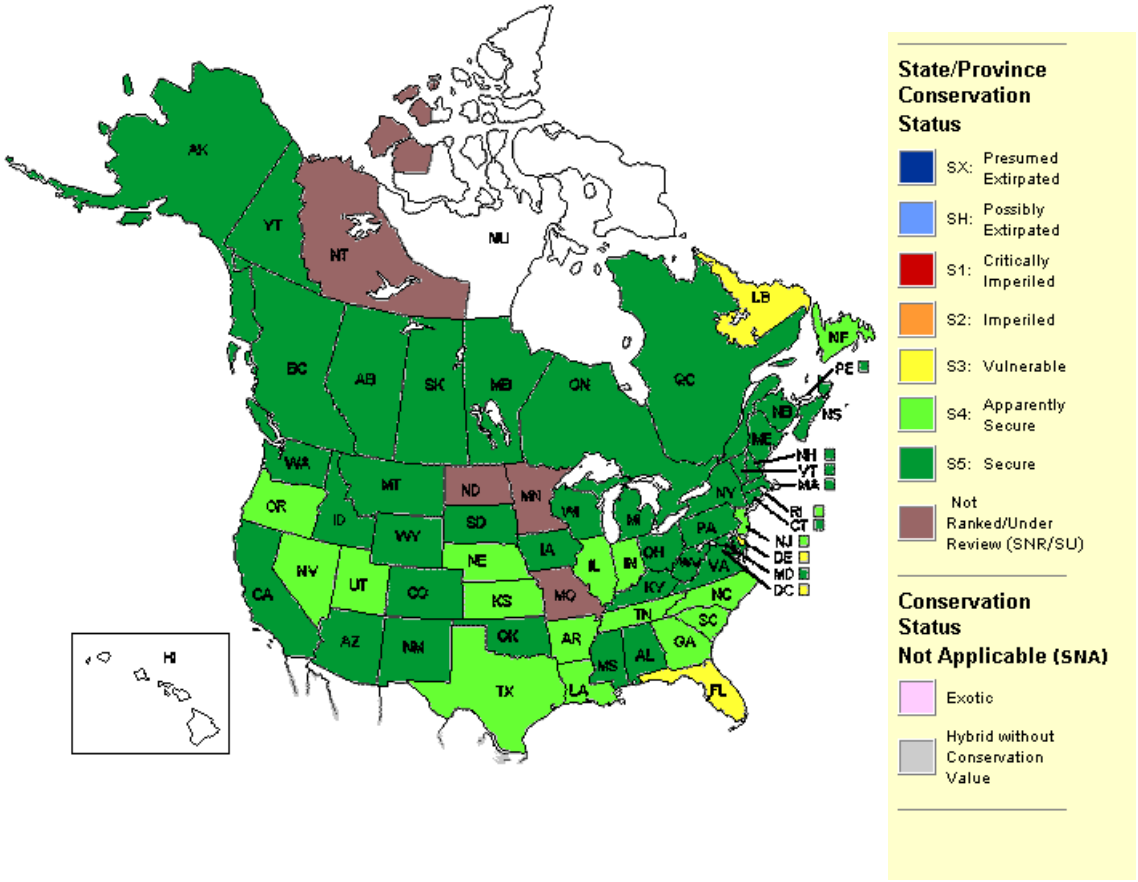
Hairy woodpeckers are year-round residents of nearly all forest types from central Canada to the highlands of western Panama, many continental islands, and some islands of the Bahamas (Scott et al. 1977; Jackson et al. 2002). The hairy woodpecker is among the most widespread and familiar of North American birds (Jackson et al. 2002). This species is common in the Southwest, particularly in riparian habitats and in ponderosa pine, mixed species, and spruce-fir forests (NMDGF 2011).

The hairy woodpecker is not on US Fish and Wildlife Service's list of bird species of conservation concern for Bird Conservation Region #16 (Southern Rocky Mountains) (USDI 2008) or listed as a species of concern under the Endangered Species Act. The overall goal of the *Birds of Conservation Concern 2008* document is to accurately identify the bird species that represent the highest conservation priorities and conservation action outside of federally listed species (USDI 2008).

The North American Breeding Bird Surveys (BBS) from 1966 – 2007 for the Southern Rocky Region shows that the hairy woodpecker is on an upward trend of 3.3 percent change per year.

The BBS has compiled estimated trends within the cavity nesters guilds (Sauer et al. 2008). Analyzing species with guilds (groups of similar life history traits) can provide additional insight into patterns of population trends. These trends estimates have been adjusted in order to take into account the relative precision of the estimated trends and provide a better ranking of change for the species relative to other species in the same guilds. The adjusted trend estimate for the hairy woodpecker (across 52 routes) indicates a non-significant increase (Sauer et al. 2008).

The *NatureServe* database (www.natureserve.org/explorer) documents that throughout its range, the hairy woodpecker is listed as "G5", (i.e., globally secure and common, widespread and abundant) although it may be rare in parts of its range, particularly on the periphery. Reasons given for the G5 ranking are its large range and that it is common in many areas and there is no evidence of large-scale declines. It is not vulnerable in most of its range. Species with this rank typically occur in more than 100 localities, and there are more than 10,000 individuals. Within the United States, the hairy woodpecker is listed as "N5" (i.e., secure and common, widespread, and abundant). In New Mexico, the hairy woodpecker is listed as "S5" (i.e., secure, common, widespread and abundant). Overall, the United States population is stable.



Map 2. Distribution of Hairy Woodpecker in North America (NatureServe Explorer 2010)

New Mexico

Monitoring information from the North American Breeding Bird Surveys in New Mexico indicates population trend is stable, abundant, and not declining. Figure 4 displays a slightly downward trend from 1968 to 2007 for the hairy woodpecker in New Mexico, with a -0.8 percent change per year. However, these results are labeled "view with caution" due to small amounts of data and are considered very imprecise (J. Sauer; pers. comm. 2011). The BBS has compiled estimated trends within the cavity nesters guilds for New Mexico. The adjusted trend estimate for the hairy woodpecker (across 21 routes) indicates a non-significant decrease trend (Sauer et al. 2008).

The hairy woodpecker is not listed in the New Mexico Bird Conservation Plan by New Mexico Partners in Flight (NMPF 2007) nor is it listed as threatened or endangered by the state of New Mexico (NMDGF 2011). Not being on these lists demonstrates there is no large-scale conservation concern for the hairy woodpecker in New Mexico at this time.

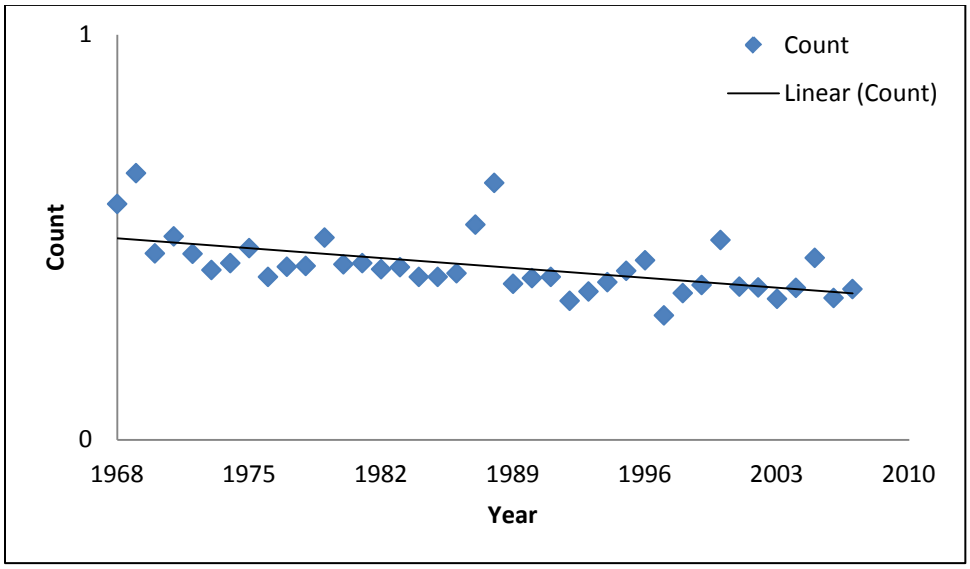


Figure 4. Estimated Trend for Hairy Woodpecker in New Mexico (Sauer et. al 2008)

Carson National Forest

Three Breeding Bird Survey routes adjacent to or within the Carson National Forest have been used to evaluate trend – Angel Fire, Cebolla (near La Placitas), and Ojo Sarco.[1] Table 2 shows the survey estimates for the three routes from 1966 to 2007. While Ojo Sarco shows a decline in trend percentage per year, the Cebolla and Angel Fire show increases.

Table 2. Breeding Bird Survey Estimates for Hairy Woodpecker (Sauer et al. 2008)

BBS Route	Trend Estimate	P value	Number of Years	Average Count
Ojo Sarco	-6.39	0.05163	39	0.51
Cebolla	3.63	0.60897	26	0.96
Angel Fire	24.70	0.10410	14	0.93

Avian surveys have been conducted on the Carson National Forest during 2003, 2004, 2005, and 2006 (Beason and Giroir 2004, Beason and Leukering 2005, Beason et. al 2006, Beason et. al 2007). In 2003, 33 hairy woodpeckers were observed in eight habitat types, with the most detections (16) in piñon-juniper (Beason and Giroir 2004). There were not the required 23 detections within a habitat type to be able to determine density of hairy woodpeckers for any one habitat type. In 2004, 85 hairy woodpeckers were detected in seven habitat types, with the most detections (27) in piñon-juniper. A density of 0.017 birds per hectare was estimated within the piñon-juniper habitat type (Beason and Leukering 2005). In 2005, 51 hairy woodpeckers were observed in six habitat types, with the most detections (27) occurring in piñon-juniper

[1] Numbers reflect the abundance of the species near the survey route. They are averages of the total counts along the route for the period 1989-1998. Because each survey route is 24.5 mi long, and consists of 50, 3-minute counts along the length of the route, the abundance estimate represents the number of birds that a very good birder would encounter in about 2.5 hours of roadside birding in the area near the BBS route.

habitat (Holmes and Johnson 2005). In 2006, 53 hairy woodpeckers were observed in five habitat types, with the most detections (26) occurring in ponderosa pine habitat (Beason et. al 2007). The maps in the 2003 through 2006 surveys show that hairy woodpeckers are well distributed across the Carson National Forest (Beason and Giroir 2004, Beason and Leukering 2005, Beason et. al 2006, Beason et. al 2007).

The higher than expected number of individuals in the piñon-juniper in the surveys from 2003 to 2005 may be related to the severe infestation of bark beetle in piñon pines and the abnormal availability of food in these areas. This may indicate an opportunistic behavioral pattern by the species. If that is the case, there may be observations of hairy woodpecker in the piñon habitats that are abnormally high and individuals that might normally be in the ponderosa pine or mixed conifer may be using this habitat instead.

In the spring and summer of 1985, a prey base analysis study was conducted in an area just west of the Questa Ranger District on public lands administered by the Bureau of Land Management (BLM) (Stahlecker et al. 1989). Data for this species comes from the wooded canyon benches habitat, which is similar to the transition zone between the piñon-juniper and ponderosa pine type that is a condition prevalent across much the Carson National Forest. This habitat type contains a mix of juniper, piñon, and ponderosa pine. The survey also includes the upland forest habitat, which is similar to the lower elevation mixed conifer habitat on the Carson, but is generally a more open canopy than most of the Carson's forested stands. The woodland canyon benches had not been harvested, while the upland forest was historically harvested. Stahlecker recorded an average 4.4 breeding pairs per 40 hectares (0.44 breeding birds/hectare) in the wooded canyon benches. The upland forest habitat type averaged 4.8 breeding pairs per 40 hectares (0.48 breeding birds/hectare) (Stahlecker et al. 1989).

Competition from other woodpecker species for cavity sites could affect populations of this management indicator species; however Stahlecker and others (1989) found northern flickers averaged almost identical population densities by habitat type. With over 600,000 acres (USDA 1987) of similar habitats on the Carson National Forest, population densities should be maintained.

Bird surveys were performed as far back as 1979 on the Jicarilla Ranger District (Flippo 1979). Flippo found the hairy woodpecker in ponderosa pine habitat. Avian inventories were also conducted on the Camino Real Ranger District in the mixed conifer and ponderosa pine from 1999 to 2001 (USDA 2001). These inventories were not specifically designed to determine breeding pair per acre, but were strip transects to determine relative abundance and occurrence. These studies indicate an estimated 22 individuals per square kilometer (0.11 individuals/ha) were encountered. Although individuals do not directly relate to breeding pair, if 50 percent of these individuals represent a breeding pair, this data indicates very similar populations to the spot mapping data collected by Stahlecker and others (1989).

Szaro and Balda (1982) studied the effects of timber harvest on breeding bird densities in ponderosa pine forest on the Coconino National Forest in Arizona. During the years of the study, hairy woodpeckers were found in all types of harvested stands, except clear cuts.[1] Hairy woodpecker densities averaged about 3 pairs/100 acres (0.07 pair/ha), and did not differ among treatments (Szaro and Balda 1982 and 1986). In eastern North America, using various forest types, hairy woodpeckers averaged 12.5 pairs/km^2 (0.125 pairs/ha). At specific sites supporting

[1] Clearcutting is not practiced on the Carson National Forest.

hairy woodpeckers, population densities are estimated to range from 0.6 pairs/km^2 (0.006 pairs/ha) to approximately 15 pairs/km^2 (0.15 pairs/ha) (Jackson et al. 2002).

Based on the information provided by BBS and from other surveys done adjacent and on the forest, **population trends of hairy woodpecker are stable on the Carson National Forest**. This corresponds with the Carson Forest Plan's description of expected conditions for the hairy woodpecker over the life of the plan – "Hairy woodpecker, plain titmouse and Brewer's sparrow populations may decrease over time in specific areas impacted by management activities, but populations will be maintained at levels greatly exceeding minimum viable populations" (USDA 1986c, p. 238). Continuing to manage the Forest according to the Forest Plan's guidelines – maintain road densities at their lowest within analysis areas across the Forest, 300 or more snags per 100 acres, large woody debris on the forest floor, increase the aspen component, decrease conifers in aspen -- will insure that hairy woodpecker habitat and populations will be maintained over time. Natural occurrences, such as wildfire and lightning strikes, can also create favorable habitat conditions for the hairy woodpecker.

REFERENCES

Balda, R.P. 1975. The relationship of secondary cavity nesters to snag densities in western coniferous forests. Wildlife Habitat Technical Bulletin 1. US Department of Agriculture, Forest Service, Southwestern Region.

Beason J.; Giroir, G. 2004. Monitoring the birds of Carson National Forest. 2003 Final Report. Revised February 2004. Carson National Forest. 78 p.

Beason J.; Leukering T. 2005. Monitoring the birds of Carson National Forest. 2004 Final Report, January 2005. Carson National Forest. 107 p.

Beason, J., K. Hutton, R. Sparks, A. Panjabi, and D. Hanni. 2006. Monitoring the Birds of Carson National Forest: 2005 Field Season Report. Tech. Rep. M-CNF05-01. Rocky Mountain Bird Observatory, Brighton, CO, 144 pp.

Beason, J., K. Hutton, R., J. Blakesley, A. Panjabi and D. Hanni. 2007. Monitoring the birds of the Carson National Forest: 2006 Field Report. Tech. Rep. M-CNF06-01. Rocky Mountain Bird Observatory, Brighton, CO, 88 pp.

Bennetts, R.E. 1991. The influence of dwarf mistletoe infestation on bird communities in Colorado ponderosa pine forests. Fort Collins, CO: Colorado State University. 83 p. M.S. thesis.

Ehrlich, Paul; Dobkin, David; Wheye, Darryl. 1988. The birder's handbook: A field guide to the natural history of North American birds. Simon and Schuster. New York, NY; 352-353.

Flippo, Mark. 1979. (unpubl.) Avian and rodent survey in the Jicarilla District of the Carson National Forest, New Mexico. 48 p.

Franzreb, Kathleen E. 1977. Bird population changes after timber harvesting of a mixed conifer forest in Arizona. Research Paper RM-184. Fort Collins, CO: US Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 26 p.

Frissel, Sidney. 1984. The impact of firewood cutting on hole-nesting birds. Western Wildlands. 9(4): 3 p.

Jackson, J.A.; Ouellet, H.R.; Jackson, B.J.S. 2002. Hairy woodpecker (*Picoides villosus*) *In* the Birds of North America, No. 702 (A. Poole and F. Gill, eds.). The Birds of North America, Inc., Philadelphia, PA.

NatureServe Explorer: An online encyclopedia of life [web application]. 2010. Version 7.1. Arlington, Virginia, USA: NatureServe. Available: http://www.natureserve.org/explorer. (Accessed: March 15, 2011).

New Mexico Department of Game and Fish. 2011. BISON-M (Biota Information System of New Mexico): Biological database for New Mexico. NMDGF in cooperation with USDI BLM, USDI FWS, USDI Bureau of Reclamation, US Army Corps of Engineers, USDA Forest Service and University of New Mexico. http://www.bison-m.org. (Accessed: May 31, 2011)

New Mexico Partners in Flight. 2007. New Mexico Bird Conservation Plan Version 2.1.C. Rustay and S. Norris, compliers. Albuquerque, NM. 41 pages.

Reynolds, Richard T.; Graham, Russell T.; Reiser, M. Hildegard; and others. 1992. Management recommendations for the northern goshawk in the southwestern United States. General Technical Report RM-217. Fort Collins, CO: US Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 90 p.

Sauer, J. R., J. E. Hines, and J. Fallon. 2008. The North American Breeding Bird Survey, Results and Analysis 1966 - 2007. Version 5.15.2008. USGS Patuxent Wildlife Research Center, Laurel, MD. Available: http://www.mbr-pwrc.usgs.gov/bbs/bbs.html. (Accessed: March 15, 2011).

Scott, Virgil E.; Evans, Keith E.; Patton, David R.; Stone, Charles P. 1977. Cavity-nesting birds of North American forests. Agriculture Handbook 511. Washington DC: US Department of Agriculture, Forest Service. 112 p.

Scott, Virgil E.; Patton, David R.; 1989. Cavity-nesting birds of Arizona and New Mexico forests. General Technical Report RM-10. Fort Collins, CO: US Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 72 p.

Stahlecker, Dale W.; Kennedy, Patricia L.; Cully, Anne C.; Kuykendall, Charles B. 1989. Breeding bird assemblages in the Rio Grande Wild and Scenic River Recreation Area, New Mexico. Southwestern Naturalist. 34(4): 487-498.

Szaro, R.C.; Balda, R. 1982. Selection and monitoring of avian indicator species: an example from a ponderosa pine forest in the Southwest. General Technical Report RM-89. Fort Collins, CO: US Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 8p.

Szaro, R.C.; Balda, R. 1986. Relationships among weather, habitat structure and ponderosa pine forest birds. Journal of Wildlife Management. 50:253-260.

Thomas J.W., ed. 1979. Wildlife habitats in managed forests — the Blue Mountains of Oregon and Washington. USDA Agriculture Handbook No. 553. US Government Printing Office, Washington, D C. 512 p.

USDA, Forest Service. 2001. Avian survey data in upland forest: 1999-2001. Southwestern Region, Carson National Forest, Camino Real Ranger District. 27 p.

USDA Forest Service. 2005. Firewood Guide: Carson National Forest.

USDA Forest Service. 2006. Use of North American breeding bird surveys on region 3 national forest and grasslands with an annotated bibliography. Unpublished briefing paper by Ernest Taylor, Regional Biologist, Southwestern Region, Albuquerque, NM. 13 p.

USDA Forest Service. 2010. Unpublished printout of forest cover types. 1 p.

USDI Fish and Wildlife Service. 1995. Recovery plan for the Mexican spotted owl (*Strix occidentalis lucida*): Volumes I and II. Albuquerque, NM: US Department of Interior, Fish and

Wildlife Service. Volume I, 172 p. and Volume II 145 p. [Online version available at: http://www.fws.gov/ifw2es/Documents/R2ES/MSO_Recovery_Plan.pdf]

USDI Fish & Wildlife Service. 2008. Birds of Conservation Concern 2008. Division of Migratory Bird Management, Arlington, Virginia. 87 p. [online version available at < http://www.fws.gov/migratorybirds/NewReportsPublications/SpecialTopics/BCC2008/BCC2008.pdf >]

Red Squirrel (*Tamiasciurus hudsonicus*)

INDICATOR SPECIES HABITAT

Red squirrel principally utilizes the mixed conifer forest type. The species is an indicator for the presence of mixed conifer (USDA 1986a, p.97). Red squirrels require mature coniferous trees as a source of cones and seed (Reynolds et al. 1992, USDA 2002a). The best cone production occurs in 200- to 300-year old Douglas-fir (*Pseudotsuga menziesii*), 40- to 300-year old white fir (*Abies concolor*), and 150- to 200-year-old Engelmann spruce (*Picea engelmannii)*. The best seed-producing stands of blue spruce (*Picea pungens*) are 50 to 150 years old (Reynolds et al. 1992, p. 71). The more diverse the tree species, the more likely cone crop production will exist to sustain red squirrel populations. They are predominantly found in areas with greater than 60 percent canopy closure (Reynolds et al. 1992; USDA 2002a). In extensive areas of montane forest, this species may be found in ponderosa pine forests where transition occurs with mixed conifer. In smaller mountain ranges, it is restricted to stands of mixed conifer or spruce-fir forests (NMDGF 2011).

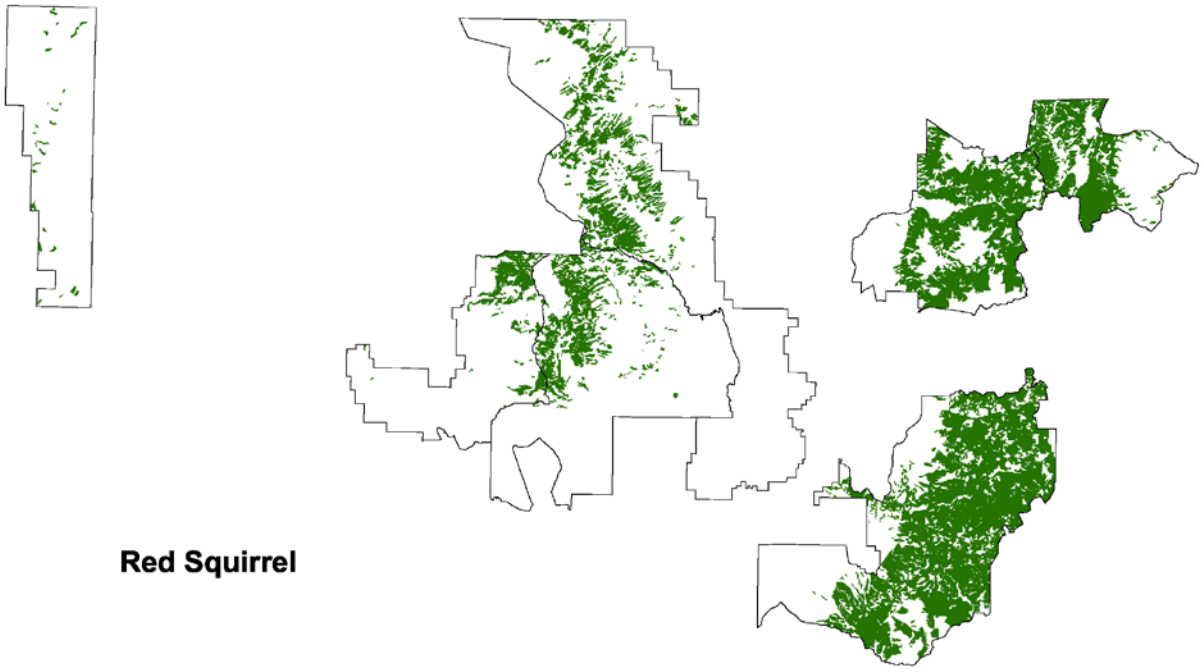
Red squirrels utilize large diameter trees for nests that are located on big branches near the trunk of the tree. They may also use mistletoe formations in Douglas-fir (Patton and Vahle 1986). Other studies have found the red squirrel will use natural cavities or woodpecker holes and seem to use nests when den sites are limited (USDA 2002a, Flyger and Gates 1982).

Food caches (middens) are of paramount importance to red squirrels (Reynolds et al. 1992, Findley 1969, Findley et al. 1975, Larson and Boutin 1994). Without these middens, winter starvation is inevitable (Kemp and Keith 1970). A large centrally located (primary) midden is the most prominent feature of red squirrel territories. These primary middens, along with several secondary middens, provide the energy requirements of a single squirrel for half of the year (Patton and Vahle 1986). Cache sites are in moist, shaded areas. At cache sites, groups of mature trees and shading from additional understory and overstory vegetation maintain the humidity necessary to prevent the cones from opening (Vahle 1978). Vahle and Patton (1983) found that 90 percent of 141 cache sites had canopy cover greater than 60 percent, and received additional shading from surrounding uneven-aged groups of trees.

Within certain habitats, the red squirrel is commonly used as prey by the northern goshawk (Reynolds et al. 1992). In the Jemez Mountains of northern New Mexico, the red squirrel comprised 5.6 percent of 36 prey deliveries to seven goshawk nests and 17.5 percent of 63 pellets analyzed from eight goshawk nests (Kennedy 1990).

Potential Habitat Distribution

On the Carson National Forest, this species is commonly observed throughout the mixed conifer and spruce-fir habitat type. Characteristic mounds or middens confirm red squirrels presence and are found throughout red squirrel habitat on the Forest. Red squirrel clippings, cone felling and stripping are also a usual sign of occurrence. As displayed on a map of the Carson National Forest (Map 1), the “potential” habitat for the red squirrel is well distributed across the Forest. Based on stand cover type (USDA 2003), there are approximately 441,844 acres of potential habitat available across the forest. Although habitat is shown for the Jicarilla Ranger District, the district is not believed to be able to maintain a red squirrel population at this time due to the small amount of fragmented habitat on the district (Frey 2003, p. 8).



Map 1. Red Squirrel Potential Habitat Distribution on the Carson National Forest (USDA 2003)

Management Activities or Natural Events That May Affect Habitat

Negative: Logging activities in mature stands, catastrophic wildfire.

Positive: Thinning smaller diameter trees to release and promote larger trees.

Plans, Regulations and Guidelines Supporting, Maintaining or Improving Habitat

- *Carson National Forest Land and Resource Management Plan, Forest-wide Prescriptions for Wildlife and Fish* (USDA 1986c) are described,

> By creating a diversity of stand conditions and providing juxtaposition of stands over time and space, suitable habitat components of Abert and red squirrels will be maintained over time. During the intensive reconnaissance phase of integrated stand management, State and Federal biologists should identify those stands where squirrel activity is especially high and recommend deferment of cutting during the entry *(USDA 1986c, p. Wildlife & Fish – 10)*.

The desired conditions for Management Areas 3, 5 and 7 are identified as quality habitat for red squirrel (USDA 1986c, p. 3. MC<40% - 1, p. 5. MC/PP >40% - 1, 7. Unsuitable - 1).

- *Record of Decision for Amendment of Forest Plans* (USDA 1996) provides guidelines relative to the management of both Mexican spotted owl and northern goshawk habitat.

  Standards and guidelines for ecosystem management in Mexican spotted owl habitat (mixed conifer on the Carson NF) include:

> *Manage to ensure sustained level of owl nest/roost habitat where appropriate while providing a diversity of stand conditions across the landscape to ensure habitat for a diversity of prey species.*
>
> *Attempt to mimic natural disturbance patterns by incorporating natural variation, such as irregular tree spacing and various patch sizes, into management prescriptions.*
>
> *Emphasize uneven-aged management systems. However, both even-aged and uneven-aged systems may be used where appropriate to provide variation in existing stand structure and species diversity. Existing stand conditions will determine which system is appropriate.*
>
> *Save all trees greater than 24 inches DBH.*
>
> *Retain substantive amounts of key habitat components:*
>
> *Snags 18 inches in diameter and larger.*
>
> *Down logs over 12 inches midpoint diameter.*
>
> *No timber harvesting (except for fire risk abatement) in mixed conifer on slopes greater than 40 percent.*
>
> *Within Mexican spotted owl restricted habitat (mixed conifer), 25 percent of the oldest and/or best nest/roost habitat (threshold) must not go below threshold values.*
>
> *…implement forest plan old growth standards and guidelines to maintain and promote development of owl habitat.* (USDA 1996, pp. 89 & 90)

Standards for ecosystem management in northern goshawk habitat include:

> *Manage for old age trees such that as much old forest structure as possible is sustained over time across the landscape. Sustain a mosaic of vegetation densities (overstory and understory), age classes and species composition across the landscape. Provide foods and cover for goshawk prey*. (USDA 1996, p. 91)

Standards and guidelines for old growth include (see USDA 1996, “Minimum Criteria for Structural Attributes Used to Determine Old Growth” table, p. 96):

> *Until the forest plan is revised, allocate no less than 20 percent of each forested ecosystem management area to old growth.*
>
> *Unless 20 percent of an ecosystem management area has been allocated to old growth, no mixed conifer stands can be treated in a manner that would take the stand out of meeting old growth criteria.*

> *Strive to create and sustain as much old growth compositional, structural, and functional flow as possible over time at multiple area scales. Seek to develop or retain old growth function on at least 20 percent of the naturally forested area by forest type in any landscape.*

- *Management Recommendations for the Northern Goshawk in the Southwestern United States* (Reynolds et al. 1992) describe the red squirrel as an important prey species for the goshawk and habitat management recommendations include:
  - ✓ Mixed-species and spruce-fir specialist
    - Closed canopy VSS 4, VSS 5, and VSS 6
  - ✓ Nesting
    - Closed canopy VSS 4, VSS 5, and VSS 6
    - Nests are close to middens
    - Nest sites have high canopy cover and the best sites are mesic
  - ✓ Foraging (considered a food specialist)
    - VSS 5 and VSS 6 (infrequent use of VSS 4)
    - Middens have high canopy cover and are mesic, preserving cones
    - High canopy cover provides mesic conditions for greater fungi production
  - ✓ Other important habitat attributes
    - Snags (>18 inches DBH) and downed logs (16-20 inches diameter) very important; smaller woody debris less important
    - High canopy cover provides escape cover for squirrels
    - Large mature cone-bearing trees, abundant fungi, and multistoried stands with many plant species in all forest layers constitute superior squirrel habitat
    - Medium to large forest openings degrade the mesic microclimate in adjacent forests, and thereby reduce the quality of red squirrel habitat (Reynolds et. al 1992).

HABITAT CONDITION AND TREND ON THE CARSON NATIONAL FOREST

The Forest Plan EIS states red squirrel will utilize the mixed conifer habitat type (USDA 1986a, p. 97). No key habitat component was identified. However, the Forest Plan EIS estimates quality red squirrel habitat at 169,400 acres, which is only about half of the total mixed conifer on the Forest. This disparity seems to indicate that habitat quality parameters were the objective. The Forest Plan also directs providing quality habitat in the mixed conifer and includes Engelmann spruce “in a wide variety of mixtures”. The red squirrel is also known to utilize the spruce-fir habitat type. Some of the higher densities of squirrels are in this cover type (Frey 2003, 2004, and 2009). In the Southwest, Engelmann spruce or a mixture of spruce and Douglas-fir are the most important and commonly inhabited forest types for the red squirrel (Vahle 1978, Reynolds et al. 1992).

Haughland and Larson (2004) determined that red squirrels are good study animals for addressing questions relating habitat and demography for several reasons: 1) both male and female squirrels define non-overlapping territories year-round; 2) their survival at least partially correlates to the type and quality of their local habitat; and 3) juvenile squirrels make round-trip forays into the environment around their natal territory prior to settlement. Their study (Haughland and Larson 2004) established that mature forest appeared to represent the highest quality habitat. Mean density, mean overwinter survival, probability of surviving the field season, and success at raising one or more juveniles to emergence were higher in mature forests. To

support the species, mature stands of mixed conifer and spruce-fir are important for adequate cone production, nest sites and canopy density (Vahle and Patton 1983, Reynolds et al. 1992, USDA 2002a, Haughland and Larsen 2004). Queries were designed with these considerations in mind. They focus on mature or large tree components and a minimum basal area to provide adequate canopy closure.

Several factors are used to determine habitat trend. Management activities (primarily timber sales) and wildfire have reduced certain habitats to unsuitable conditions. High intensity wildfire and certain harvest prescriptions such as overstory removal, seed cuts, and shelterwood harvests are examples of areas that are deducted from the total acres of quality mixed conifer and spruce-fir habitat. Total stand acres are not deducted. Only the actual acres treated that are estimated to result in acres becoming unsuitable are deducted. In an appendix, a management indicator species habitat trend analysis explains in more detail how habitat trend is determined.

Suitable stands (2,580 ac) that had experienced high intensity fire were removed from squirrel habitat. In addition, suitable habitat lost to timber harvest (13,391 ac) was deducted. Recent estimates are that 100 acres per year have been harvested between 2005 and 2011 (T. Fruits; pers. comm. 2011). Also taken into account is forest succession, where mixed conifer and spruce-fir stands have progressed towards more quality habitat since 1986. A conservative estimate of stands moving to suitability is one percent of the overall mixed conifer and spruce-fir on the Forest from 1986 to 2002 (see Appendix). Table 1 reflects this same rate of ingrowth through 2011.

Table 1. Red Squirrel Suitable Habitat Acres: Change from Wildfire, Logging, and Tree Growth 1986-2011

Ranger District	Total MC and SF Acres	Estimated Acres of Habitat	Habitat Acres Reduced by Wildfire*	Habitat Acres Reduced by Logging**	Total Acres Reduced	Total Acres of Ingrowth	Remaining Acres of Red Squirrel Habitat
D1, D2, D6[1]	121,463	68,864	0	7,357	7,357	818	62,318
D3	1,943	933	0	0	0	10	943
D4	173,383	111,171	80	4,072	4,152	1,320	108,339
D7	145,055	36,638	2,500	1,362	3,862	434	33,210
Total	441,844	217,606	2,580	13,391**	15,971	3,400	205,035

*Numbers for habitat acres reduced by wildfire are through 2007

**Total habitat acres reduced by logging reflects an additional 600 acres (100/acres per year for 2005-2011) that are not reflected in the numbers for individual districts

From 1986 to 2011, red squirrel habitat of interlocking canopies in mixed conifer and spruce-fir is estimated to have increased from 169,400 (per the 1986 Forest Plan) to 205,035 acres or an upward trend of about 20 percent.

[1] D1 = Canjilon, D2 = El Rito, D3 = Jicarilla, D4 = Camino Real, D6 = Tres Piedras, D7 = Questa

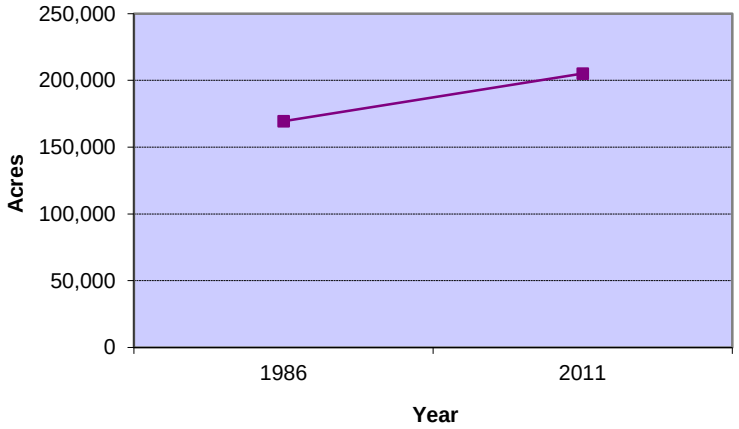


Figure 1. Changes in Red Squirrel Suitable Habitat on the Carson National Forest from 1986 to 2011.

Forest Management Activities

In southwestern mixed conifer forests, size, density and grouping of coniferous trees are the most important overstory components of red squirrel habitat. In the right combinations, these factors provide squirrels with optimum conditions for food procurement, nesting cover and food caching sites (Vahle and Patton 1983). Vahle and Patton (1983) recommended maintenance of areas with closely spaced groups of trees of different ages and sizes for red squirrel habitat.

At least three or four large trees per acre are needed, as conifers larger than 15 inches diameter at breast height (DBH) are necessary for cone production. For Douglas-fir, 200- to 300- year-old trees are the best cone producers (Reynolds et al. 1992). The number of cones required to sustain a single red squirrel for a year ranges from 42,000 to 131,000, thus 9 to 25 large, mature cone-producing trees per territory (0.2 to 4.45 hectare) are necessary (Reynolds et al. 1992, p. 71; Patton and Vahle 1986).

In addition, one or more large tree components (>20 inches DBH), consisting of snags, fallen logs, and live trees, are necessary for primary middens. Closed canopies (basal areas $\geq$ 200 square feet per acre) are also important for maintaining mesic conditions for middens and suitable cover for nesting. To provide adequate conifer seed for food, 3 to 4 large ($\geq$ 18 inches DBH) trees are needed per acre (Vahle 1978).

Red squirrel populations depend on cone production and reproductive sites. Cone production varies by year, depending on available moisture or harvest activities that may open the canopy. Harvest activities can have mixed results regarding cone production. In a managed forest, method of overstory removal significantly influences red squirrel habitat. Harvesting will generally stimulate cone production in the spruce-fir, but excessive canopy opening can create a drier condition that reduces the amount of cone production.

The group selection method provides undisturbed groups of all-aged trees and promotes habitats favored for red squirrel cache sites. Squirrels prefer groups that are mostly dense and contain large conifers, snags and downed logs (Vahle and Patton 1983). Reynolds and others (1992) listed specific management recommendations for red squirrels in the Southwest in conjunction with maintenance of northern goshawk prey base (see previous section). Cone production may be influenced by spring freezing and to some degree by wind throw, which can be locally significant.

The maintenance of many mature coniferous forest types is often dependent on fire. Ponderosa pine, Douglas-fir, lodgepole pine, whitebark pine, and spruces are either dependent on stand replacing fires for regeneration or on low-severity fires for maintenance. Even though severe fire is immediately destructive of red squirrel habitat, the long-term maintenance of most coniferous forests is dependent on fire (USDA 2002a).

The dominant mid-seral conditions on the Carson primarily relate to cumulative effects of historical heavy logging, primarily railroad logging in the early 20th century, and long-term fire suppression. Overstory removal prescriptions also contributed to the trend towards smaller diameter stands. Over the past decade, most of the vegetation treatments in red squirrel habitat have shifted away from sawtimber and more towards wildlife habitat improvement. Since 1995, the Carson National Forest has focused on thinning from below, with little or no timber activity in the mixed conifer. More emphasis has also been placed on personal use products such as vigas and latillas.

Vegetation treatments since 1986 have been consistent with the Forest Plan, creating small openings and retaining large cone producing trees for red squirrel foraging opportunities. Although timber harvest has dropped dramatically (97%) across the majority of the Carson National Forest in the past decade, a common practice throughout the period of the Forest Plan (1986), with regard to harvest activities, was to locate and avoid patches around squirrel middens (see Forest Plan direction in previous section). The untreated stands continue to provide and maintain a closed canopy for fungi production and mesic conditions**. As a result the current habitat condition for this species is relatively good, with an upward trend.**

Current management practices on the Forest place more emphasis on thinning and prescribed burning, increasing the desired habitat in mixed conifer. Prescribed fire controls dense conifer reproduction and can improve the habitat for the red squirrel. Thinning of smaller diameter trees in mixed conifer stands can reduce inter-tree competition for moisture, nutrients and light, and stimulate growth of residual trees. In addition, dense stands of trees are prone to catastrophic wildfire, which could completely remove red squirrel habitat, affecting local populations. By thinning dense stands, the risk of a catastrophic wildfire is reduced.

The Figure 2 shows that between 1986 (when the Carson Forest Plan was implemented) and 2011; approximately six percent of the “potential” red squirrel habitat has been actively managed for timber production.

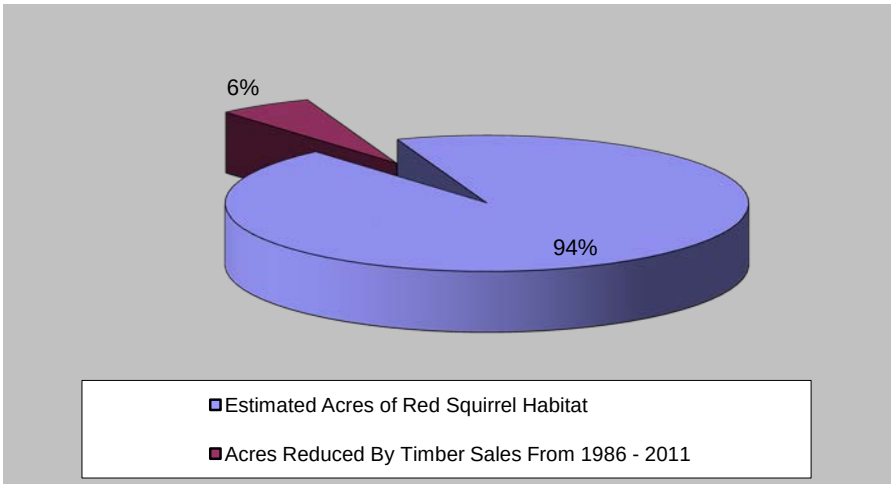


Figure 2. Proportion of Red Squirrel Habitat Reduced by Timber Sales on the Carson National Forest From 1986 to 2011

Standards and guidelines incorporated in the Carson Forest Plan through the 1996 Region-wide amendment of forest plans (USDA 1996) restrict management activities within the mixed conifer. These include no harvest in mix conifer stands on slopes greater than 40 percent; retention of 25 percent of Mexican spotted owl threshold habitat; and retention of 20 percent of the ecosystem management area in old growth stands.

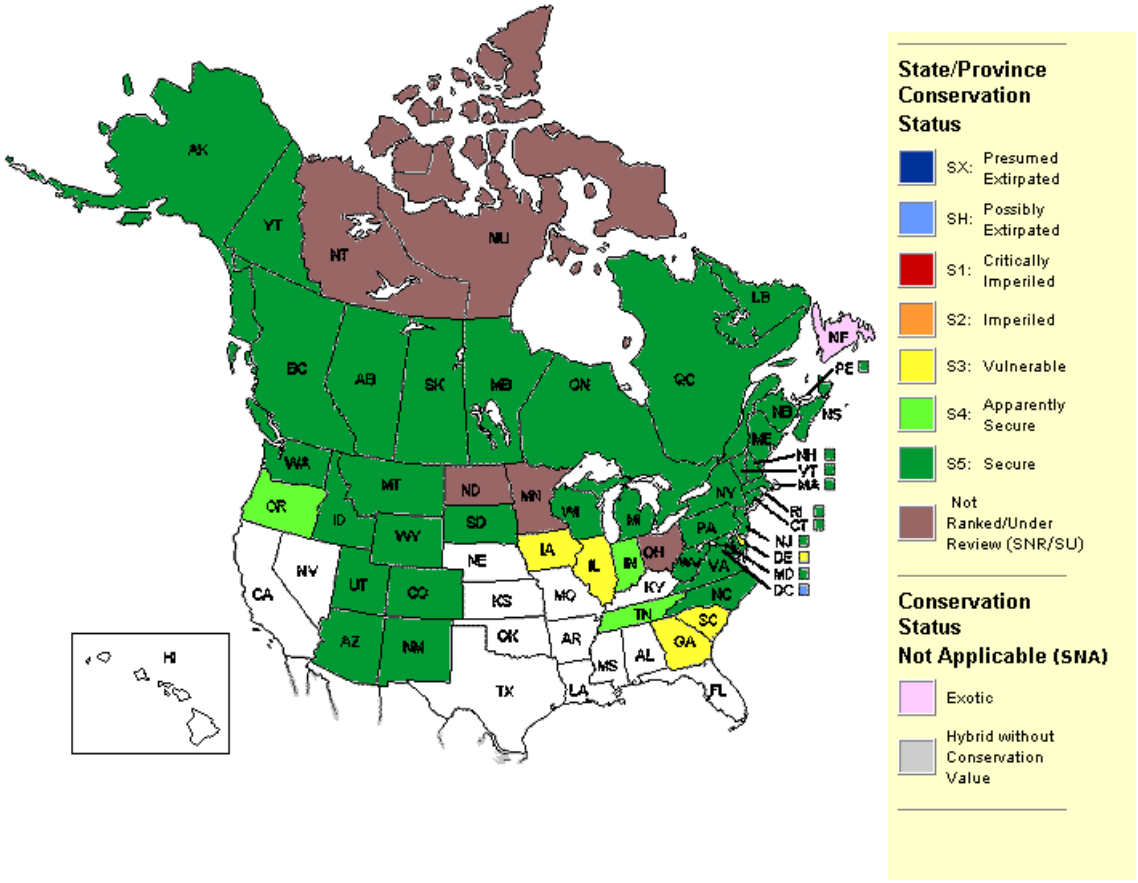
In addition, there are over 254,000 acres of wilderness areas (Wilderness Act 1964), wild and scenic river areas (Wild and Scenic Rivers Act 1968), roadless areas (USDA 1986c, 20. Semi-primitive-2), slopes > 40 percent (USDA 1986c, 5. MC/PP >40% - 2 and Timber – 12) and special management areas (USDA 1986c, 19. Special Areas – 2) on the Carson National Forest that have management direction through the Forest Plan or federal laws that exclude harvesting.

POPULATION TREND

Red squirrels are year-round residents of forest types from Alaska to Newfoundland, south to the southern Appalachians and through the Rocky Mountains to Arizona and New Mexico (Findley 1969, Flyger and Gates 1982, Patton and Vahle 1986, Reynolds et al. 1992). This species is widespread in North America and abundant in many areas (NatureServe 2010). Overall, the US population is stable.

Regional

The *NatureServe* database (www.natureserve.org/explorer) documents that throughout its range, the red squirrel is listed as “G5”, (i.e., globally secure and common, widespread and abundant). Reasons given for the G5 ranking are its large range and that it is common in many areas and there is no evidence of large-scale declines. It is not vulnerable in most of its range. Species with this rank typically occur in more than 100 localities, and there are more than 10,000 individuals. Within the United States, the red squirrel is listed as “N5” (i.e., secure and common, widespread, and abundant).



Map 2. Distribution of Red Squirrel in North America (NatureServe Explorer 2010)

New Mexico

In New Mexico, the red squirrel is listed as “S5” (i.e., secure, common, widespread and abundant) (NatureServe 2010). Information from the Bison-M database indicates that this species is fairly common throughout mixed conifer and spruce-fir forests of New Mexico and Arizona (NMDGF 2011). In 1988, the NM Department of Game and Fish listed the red squirrel as a game mammal (NMDGF 1988). There is no indication or documentation that red squirrels are declining in the Southwest.

State-wide harvest data indicates a slight decrease in mean harvest from 1983 to 1999 (NMDGF 2001). Population trends, however, are not necessarily directly correlated with harvest data. It is possible that the popularity of squirrel hunting is declining slightly. However, it is just as likely that some degree of correlation can be made. When populations are increasing, the popularity of the squirrel hunting is likely to be more appealing.

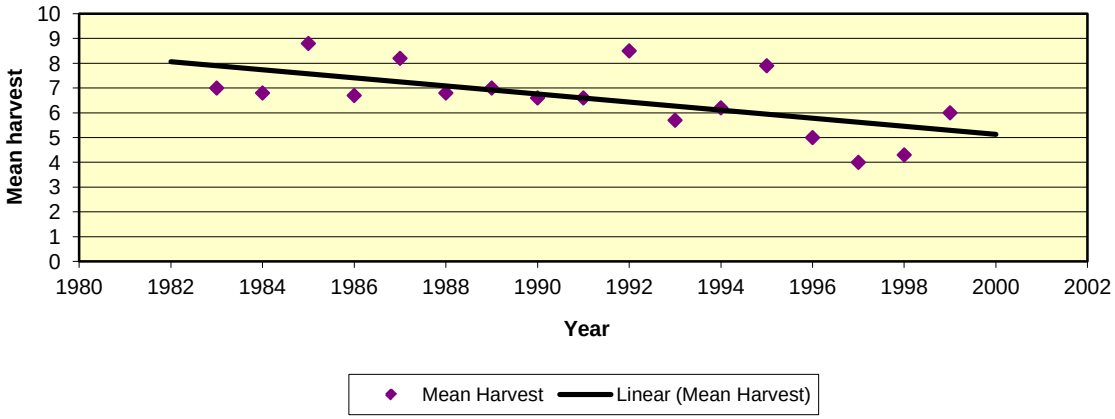


Figure 3. Mean Harvest Red Squirrel for New Mexico (NMDGF 2001)

Carson National Forest

Many studies, reviewed by Klenner and Krebs (1991), indicated that red squirrel population density varies with cone crops. The Forest Service (USDA 2002a) reported that summer populations fluctuated between 67 and 151 red squirrels per 2,500 acres (0.06 to 0.15 squirrels/ha) in mixed habitats. Spring density of adult red squirrels over a 50-year period averaged 1.1 squirrel/acres (2.72/ha) in spruce fir, 0.7/ac (1.74/ha) in mixed species forest, and 0.4/ac (0.99/ha) in pine forests (Reynolds et al. 1992). Vahle and Patton (1983) estimated population densities from 0.4 to 1.0 squirrel/acre (0.99 to 2.48/ha) in old growth mixed species forests. Reynolds and others (1992) documented estimated red squirrel densities of 0.03 to 0.32/acre (0.07 to 0.794/ha) in mixed species forests of the Sacramento Mountains, New Mexico.

The Carson National Forest collected population data for the red squirrel in 2003, 2004, and 2009 using midden density surveys developed by Frey (2003). Larsen and Boutin (1994) state the "activity center of each squirrel territory is conspicuously marked by the presence of a midden." They also maintain midden sites are traditional, and when a territory owner is replaced, the new squirrel continues to utilize the established midden. Vahle and Patton (1983) also documented active primary caches (middens) can be used as a reliable indicator of minimum squirrel populations.

Surveys on the Carson National Forest show population levels are consistent with the rest of the state and the population appears to be stable throughout its range (Frey 2003, 2004, and 2009). The overall mean density for the red squirrel was 0.47/ac (1.16/ha) in 2003, 1.04/ac (2.58/ha) in 2004, and 0.60/ac (1.43/ha) in 2009. Table 2 shows the density estimates by habitat type and year.

Table 2. Carson National Forest Survey Data (Mean Density/Acre) (Frey 2003, 2004, and 2009).

	Mixed Conifer	White Fir	Blue Spruce	Engelmann Spruce	Spruce-Fir
2003	0.17 (.42/ha)	0.15 (0.36/ha)	0.97 (2.40/ha)	0.43 (1.07/ha)	0.81 (2.00/ha)
2004	0.36 (0.90/ha)	0.56(1.38/ha)	1.32 (3.26/ha)	1.04 (2.58/ha)	1.97 (4.87/ha)
2009	0.44 (1.09/ha)	0.53 (1.30/ha)	0.76 (1.89/ha)	0.54 (1.33/ha)	0.65 (1.60/ha)

Frequent observations and the extensive distribution and abundance of mixed conifer and spruce-fir forest are indicative of the species continuing to survive and reproduce successfully across the Forest. In fact, in 2004 while doing avian surveys on the Forest, Beason and

Leukering (2005, p. 99) detected enough red squirrels in spruce-fir (49 squirrels) that they could estimate the density of red squirrels to be 0.35 per hectare (0.14/ac) using DISTANCE program. This program is based on visual detection of a species and it is reasonable for it to show a lower density then midden density surveys, especially when the visuals were incidental sightings of red squirrels while surveying for birds species.

Based on the regional and New Mexico trend data, as well as, survey data collected on the Forest, **the Carson is supporting stable populations of red squirrel.** Older seral stages of trees found throughout the Forest are being maintained and/or increased, improving habitat diversity, as well as old growth, that red squirrels depend on. This confirms what the Forest Plan predicts of squirrel populations over the course of plan implementation – "…populations are expected to increase because of improved habitat condition" (USDA 1986c, p. 238).

Figure 4. Red Squirrel Midden on Carson National Forest (2005)

REFERENCES

Beason, Jason; Leukering, Tony. 2005. Monitoring the birds of Carson National Forest: 2004 Final Report. Brighton, CO: Rocky Mountain Bird Observatory. 107 p.

Findley, J.A.; Harris A.H.; Wilson, D.E.; Jones, C. 1975. Mammals of New Mexico. Albuquerque, NM: University of New Mexico Press: xxii + 360 p.

Findley, R.B., Jr. 1969. Cone caches and middens of *Tamiasciurus* in the Rocky Mountain Region. University of Kansas Mus. Nat. Hist. Misc. Publ. 51:233-273.

Flyger, Vagn; Gates, J. Edward. 1982. Pine squirrels: *Tamiasciurus hudsonicus* and *T. douglasii*. In: Chapman, Joseph A.; Feldhamer, George A., eds. Wild mammals of North America: Biology, management, and economics. Baltimore, MD: The Johns Hopkins University Press: 230-238.

Frey, J. 2003. Initiation of red squirrel (*Tamiasciurus haudsonicus)* monitoring on Carson National Forest, New Mexico. A Final Contract R3-02-03-12 Completion Report. Carson National Forest, 31 December 2003. 38 p.

Frey, J. 2004. Red squirrel (*Tamiasciurus haudsonicus)* monitoring and habitat analysis on Carson National Forest, New Mexico, 2004. A Final Contract 43-83A7-4-0038 Completion Report. Carson National Forest, 9 December 2004. 45 p.

Haughland, Diane L.; Larsen, Karl W. 2004. Ecology of North American red squirrels across contrasting habitats: Relating natal dispersal to habitat. Journal of Mammalogy. 85(2): 225-236.

Kemp, G.A; Keith, L.B. 1970. Dynamics and regulation of red squirrel (*Tamiasciurus hudsonicus*) populations. Ecology. 51(5): 763-779.

Kennedy, Patricia L. 1991. Reproductive strategies of northern goshawks and Cooper's hawks in north-central New Mexico. Logan, UT: Utah State University. 22 p. Ph.D. dissertation.

Klenner, Walt; Krebs, Charles J. 1991. Red squirrel population dynamics: The effect of supplemental food on demography. Journal of Animal Ecology. 60: 961-978.

Larson, Karl W.; Boutin, Stan. 1994. Movements, survival, and settlement of red squirrel (*Tamiasciurus hudsonicus*) offspring. Ecology. 75(1): 214-223.

NatureServe Explorer: An online encyclopedia of life [web application]. 2010. Version 7.1. Arlington, Virginia, USA: NatureServe. Available: http://www.natureserve.org/explorer. (Accessed: March 18, 2011).

New Mexico Department of Game and Fish. 1988. New Mexico Statutes Annotated Chapter 17, Game and Fish, Pamphlet #33, Replacement Pamphlet, 17-2-3. Protected wildlife species and game fish defined. Charlottesville, VA: Michie Co., Law Publishers.

New Mexico Department of Game and Fish. 2001. Analysis of New Mexico Department of Game and Fish small game harvest surveys of 1999-2000. Professional Service Contract No. 01-516.35. Santa Fe, NM: Chaparral Systems Corporation.

New Mexico Department of Game and Fish. 2011. BISON-M (Biota Information System of New Mexico): Biological database for New Mexico. NMDGF in cooperation with USDI BLM, USDI FWS, USDI Bureau of Reclamation, US Army Corps of Engineers, USDA Forest Service and University of New Mexico. http://www.bison-m.org. (Accessed: March 23, 2011)

Patton, David R.; Vahle, J.R. 1986. Cache and nest characteristics of the red squirrel in an Arizona mixed conifer forest. Western Journal of Applied Forestry. 1: 48-51.

Reynolds, Richard T.; Graham, Russell T.; Reiser, M. Hildegard; and others. 1992. Management recommendations for the northern goshawk in the southwestern United States. General Technical Report RM-217. Fort Collins, CO: US Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 90 p.

USDA Forest Service. 1996. Record of decision for amendment of forest plans – Arizona and New Mexico. Albuquerque, NM: US Department of Agriculture, Forest Service, Southwestern Region. 96 p.

USDA Forest Service. 2002a. Fire Effects Information System, [Online]. Available: http://www.fs.fed.us/database/feis/. Fort Collins, CO: US Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory.

USDA Forest Service. 2002b. Red squirrel monitoring on the Camino Real Ranger District,

USDA Forest Service. 2010. Carson National Forest stand exam summary by cover type. Unpublished 1 p.

Vahle, J. Robert. 1978. Red squirrel use of southwestern mixed coniferous habitat. Tempe, AZ: Arizona State University. M.S. thesis.

Vahle, J. Robert; Patton, David R. 1983. Red squirrel cover requirements in Arizona mixed conifer forests. Journal of Forestry. 81(1): 14-15.

Wauters, Luc; Lens, Luc. 1995. Effects of food availability and density on red squirrel (*Sciurus vulgaris*) reproduction. Ecology. 76(8): 2460-2469.

Wheatley, Matthew; Larsen, Karl; Boutin, Stan. 2002. Does density reflect habitat quality for North American red squirrels during spruce-cone failure? Journal of Mammology. 83(3): 716-727.

Elk

INDICATOR SPECIES HABITAT

The Carson Forest Plan identifies elk as an indicator of general forest habitat type (USDA 1986a, p.97). The Rocky Mountain elk (*Cervis elaphus nelsoni*) is found on the Carson National Forest and is the species that is monitored as the Forest's management indicator. Rocky Mountain elk is a large North American ungulate that uses a variety of habitats. Because elk have had a historically wide distribution, their preferred habitat also varies widely (Skovlin 1982). Populations in the mountainous West tend to inhabit coniferous forests associated with rugged, broken terrain or foothill ranges. Certain habitat types may temporarily be of limited value to this species due to environmental conditions such as snow depth, water availability and/or vegetation components. However, they are extremely adaptable to a wide variety of successional stages and vegetation types. During the summer, elk spend most of their time in high mountain meadows in the alpine or subalpine zones or in stream bottoms (Adams 1982). In the Pacific Northwest elk prefer the denser, coniferous rainforests, while Southwestern populations can be found in open scrublands. Studies of elk slope preferences indicate that elk use a variety of slope percents, although they choose slopes in the 15 to 30 percent class most frequently (Skovlin 1982).

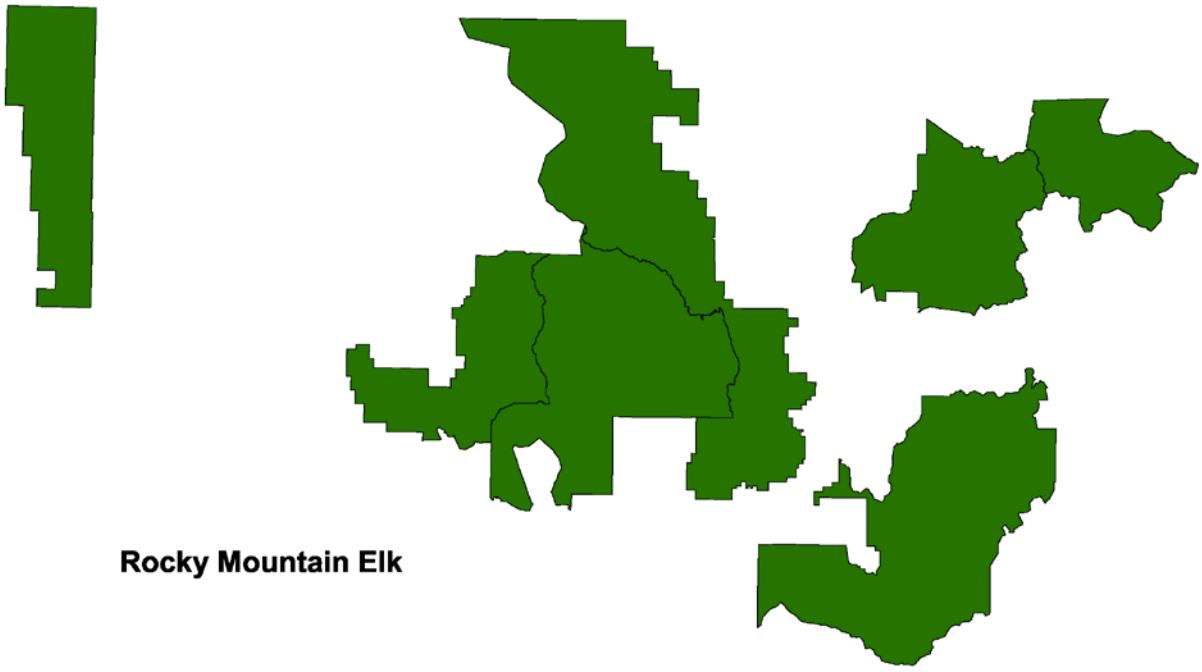
The summer months are particularly important for elk to build body condition and accumulate fat as an energy store for the winter. Nutritional demands during the summer months include lactation in cows, antler growth in bulls and growth in calves. Habitats favored by elk during the summer months are moist parks, meadows and riparian areas, offering succulent forage and bedding sites. During hot weather, elk seek shaded, cool habitats (Leege 1984). Elk remain on summer range until forced down to lower elevations by snow or severe weather (Edge et al. 1987, Leege 1984).

During the winter months, less forage is available, and its nutritional value and digestibility are at a minimum level, thus forage availability is a key factor to elk. Winter range usually consists of lower elevation, south-facing slopes and areas with good thermal cover nearby.

Elk need cover for protection against heat and extreme cold, as well as hiding and calving cover. Ideal cover is grasslands or meadows interspersed with forests that have large amounts of edge (Skovlin 1982). Elk use of open areas tends to decrease at 110 yards from cover. Calving cover requirements vary from place to place and within populations. Security or hiding cover is necessary in places of human disturbance (Peek et al. 1982). Elk may use more open areas during spring and summer because of earlier spring green-up (Edge 1987).

Elk are ruminant herbivores; their food habits are extremely variable throughout their range. Some elk populations prefer to graze, while others rely more heavily on browse. Grasses and forbs are preferred during spring and early summer, and woody shrubs and plants are preferred during winter. Elk browse conifers in areas where snow covers other forage.

As displayed on the following map, the entire Carson National Forest (>1.5 million acres) supports habitat for this species and elk are commonly observed throughout the Forest (USDA 1987).



Map 1. Rocky Mountain Elk Potential Habitat Distribution on the Carson National Forest (USDA 1987)

Management Activities or Natural Events That May Affect Habitat

Negative: Primarily related to long-term cumulative effects of dense forest conditions following heavy logging and long-term fire suppression. In addition, human disturbance from high road densities and growing private development in winter range.

Positive: Timber harvest, thinning, prescribed fire and wildfire.

Plans, Regulations and Guidelines Supporting, Maintaining or Improving Habitat

- *Carson National Forest Land and Resource Management Plan – Forest-wide Prescriptions* for Rocky Mountain elk are found in the *Wildlife and Fish* section of the Forest Plan described at the end of this section. (USDA 1986c)
  - ✓ Management areas 1-9 and 11-14 all have desired conditions to provide quality habitat for elk.

HABITAT CONDITION AND TREND ON THE CARSON NATIONAL FOREST

The Forest Plan EIS identifies 1,362,760 acres as occupied habitat for elk on the Carson National Forest (USDA 1986a, p.97). The EIS projected an improvement in elk habitat conditions as the number of structural improvements (e.g., water developments) and nonstructural improvements (e.g. aspen regeneration) increased on the Forest (USDA 1986a, pp. 98 and 152).

In reviewing the management areas identified in the Forest Plan, sagebrush is not included in the acres of occupied elk habitat (USDA 1986c). Elk are currently utilizing the majority of the sagebrush habitat type on the Carson National Forest. Elk are extensively using the piñon-

juniper woodlands intermixed with sagebrush, and in doing so, are also dispersing into the adjacent sagebrush habitat type.

The current vegetation cover type data shows 81,752 acres of sagebrush on the Forest, with the majority being on the Tres Piedras Ranger District (USDA 2003a). The Carson wildlife biologist estimates elk regularly use at least 75 percent of this cover type for several months to year-round (Cortez per comm. 2003). Therefore, it is estimated that elk habitat on the Carson National Forest has been previously understated by 61,314 acres (75% of total sagebrush habitat). Our estimate of total Carson habitat has thereby increased **from 1,362,760 to 1,424,074 acres or upward by almost 4 percent.**

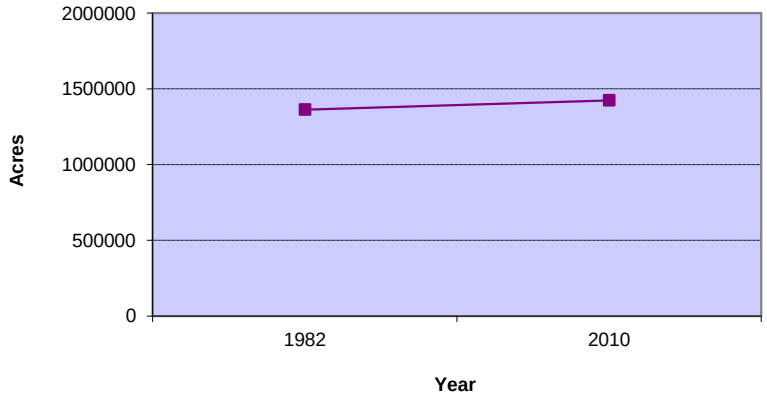


Figure 1. Changes in Elk Suitable Habitat on the Carson National Forest from 1986 to 2010.

Forest Management Activities

Off-Highway Activities - Forest management activities are generally thought to be project-related vegetation treatments that are planned by the Forest. However, some activities that must be managed include those which are public uses that simply evolve over time. One area that directly affects quality of habitats is off-highway vehicle (OHV) use. A subset of that category is all terrain vehicle (ATV) use. ATV use on public lands has increased seven-fold during the past 20 years, and many conservation groups are calling for wide-spread restrictions on ATV travel (Wisdom et al. 2004b).

Studies indicate movement rates of elk are substantially higher during periods of off-road activities compared to periods of no human activity (Wisdom et al. 2004b). Of the several types of activities examined, ATV use had the highest impact. The combination of uses is thought to have a substantial effect on elk behavior. The energetic costs may also have potential effects related to elk mortality. “For example, if the additional energy required to flee from an off-road activity reduces the percent body fat of elk below 9 percent as animals enter the winter period, the probability of surviving the winter is extremely low.” (Wisdom et al. 2004b)

OHV on-road uses also have an effect on quality of habitat and population responses of elk. Among disturbances to elk habitat, roads have been viewed as a major factor influencing distributions of elk across the landscape (Rowland et al. 2004). This study indicates there are two broad categories of effect from roads: 1) indirect effects on habitats occupied by elk; and 2) direct effects on individual elk and their populations. The total loss of elk habitat from road construction varies, but a rough estimate is about five acres per linear mile. Besides mortality from collisions with motorized vehicles, effects are summarized as:

> Elk avoid areas near open roads. This response varies in relation to traffic rates. Responses may also vary between sexes, with bulls demonstrating a stronger avoidance of areas close to roads than do cow elk. Elk also were also farther from open roads during the daytime than at night.
>
> Elk vulnerability to mortality from hunter harvest and from poaching increases as open road density increases.
>
> In areas of higher road density, elk exhibit higher levels of stress and increased movement rates.

On November 9, 2005, the Forest Service published the travel management rule, governing use of motor vehicles on NFS lands. The Carson National Forest began its review process with several pre-scoping public comment meetings in 2006 and 2007. The Carson is expected to conclude the travel management rule process in late 2011, with implementation to commence in the spring of 2012. The travel management rule process will result in designation of roads and trails open to motor vehicle use. Motorized use will be prohibited off designated roads and corridors. The publication of the Motor Vehicle Use Map will be the tool for designating motorized travel on the forest. Proper signage of open travel ways will be the first tool; gates and other closure devices will be used to preclude illegal use of motorized vehicles off designated roads and trails. Law enforcement patrols will be emphasized. Road densities (open to motorized uses) will be reduced as roads and trails are converted to nonmotorized use.

The Carson anticipates compliance with the travel management rule will have substantive benefits to elk: 1) habitat near closed roads will become available for forage and cover; 2) energy costs associated with motorized traffic on closed roads will be eliminated; and 3) winter survival rates will increase as a result of enhanced habitat and reduced energy costs.

Other Management Activities - It is a general consensus among Carson National Forest biologists that the number of elk on the forest has steadily increased since the inception of the Forest Plan in 1986. Increasing populations, however, do not necessarily translate to good habitat conditions. Logging, livestock grazing, and fire suppression have all contributed to a considerable change in structural diversity on the Carson National Forest over the last 100 years -- including understory plants.

Many disturbance events over the past century (primarily wildfires) have not been allowed to run their natural courses. A disturbance regime of frequent, low-intensity fires has been replaced with one of stand-replacing, high intensity fires. Consequently, disturbance events have become less frequent, but more severe. Forestry practices further reduced the spread of fires. Major logging efforts in the Southwest began with the harvest of railroad ties and other products for construction of the transcontinental railroad in the 1870s and 1880s and continued through the 1980s (Dahms and Geils 1997). As the large ponderosa pine and Douglas-fir trees were harvested, they were replaced by numerous seedlings that were not thinned by fire as in the past.

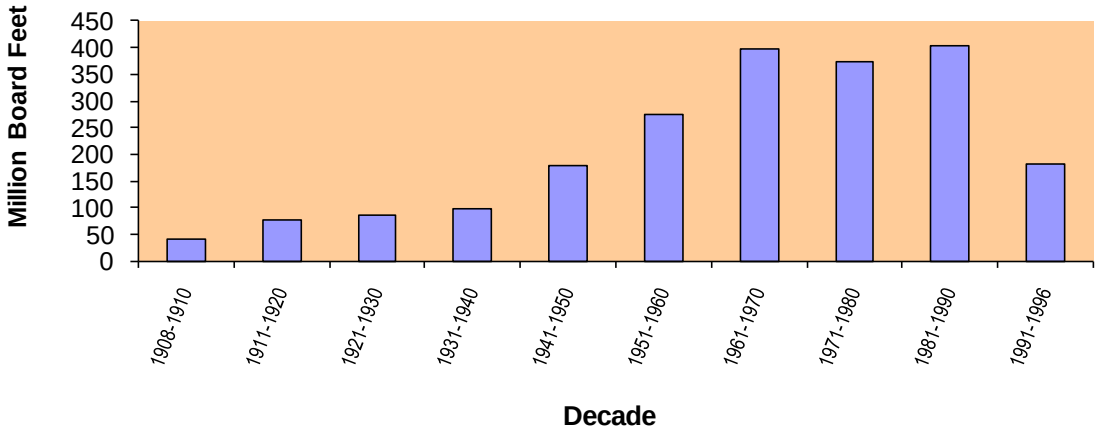


Figure 2. Average Annual Volume Cut in the Southwest 1908 – 1996 (MMBF)

Suppression of natural disturbances and the removal of late seral vegetation through logging have resulted in an artificial overabundance of mid-seral communities (Dahms and Geils 1997). This effect has been exacerbated by significant declines in timber harvest for more recent years. Dense thickets of sapling and pole stands have replaced the open structure of historic forests in the Southwest (Harrington and Sackett 1990). Expanding coniferous thickets have suppressed understory plants.

In addition to the effects of fire suppression and logging patterns, intense livestock grazing has not only removed the fine fuels needed to carry a fire, but shifted the competitive advantage from the herbaceous understory to tree seedlings. This has also increased tree density within the forest and allowed tree expansion into meadows. Over large areas, important components of structural diversity, namely meadows, open-canopy, and old growth forests, have been converted to pine and fir thickets (Moir and Fletcher 1996).

Changes in disturbance regimes and other forest processes have resulted in a transformation of forest conditions such as structure and composition. Forage has decreased as a result of fire suppression and fewer vegetation management treatments, such as thinning and group selections, which create small openings and transient range. In contrast, cover has increased as trees encroach on forage areas. In the last decade, the Carson National Forest has increased vegetation treatments, such as thinning and brushhogging, as well as prescribed burning. Both management activities increase forage and create more openings in the forest canopy.

The relationship between overstory density and understory productivity has been documented in numerous studies (Dahms and Geils 1997). Moore and Deiter (1992) report on the relation between stand density index[1] and understory productivity in a ponderosa pine forest on the Kaibab Plateau. Productivity of grasses, sedges, forbs, and shrubs decreased with stand density index.

[1] A relative measure of competition in a forest stand based on number of trees per unit area and average tree size.

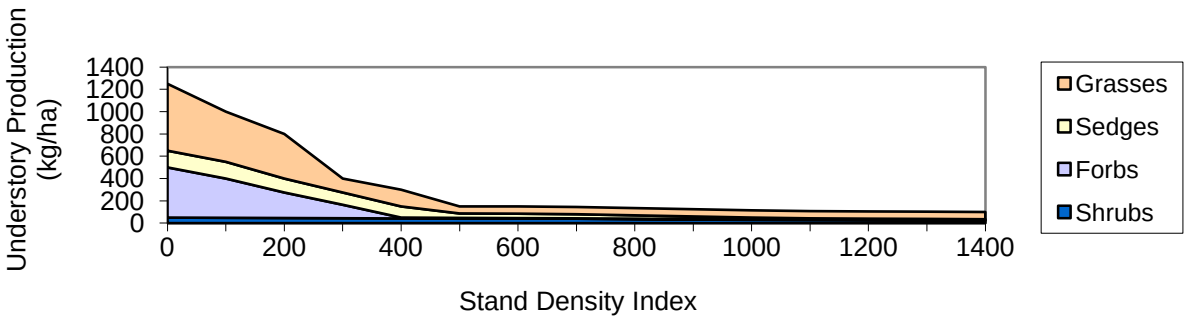


Figure 3. Understory Productivity by Stand Density Index of Ponderosa Pine on the Kaibab Plateau, AZ (redrawn from Moore and Deiter 1992).

On the Carson, the majority of elk habitat is in a mid-seral condition with a lack of widely distributed understory forage in the forested types. This results in increased competition between numerous species of wildlife and livestock in key pastures. Most livestock allocations were made during the period of heavy timber harvest, which created transient range and provided for much higher levels of forage production for all ungulates. Increasing elk populations have contributed to higher utilization levels on important foraging areas such as meadows and riparian areas. The same sites are also key livestock grazing areas. With the decline in timber practices on the Forest and continued fire suppression, canopy closure and duff layers are increasing, thus reducing understory forage production in the forested types.

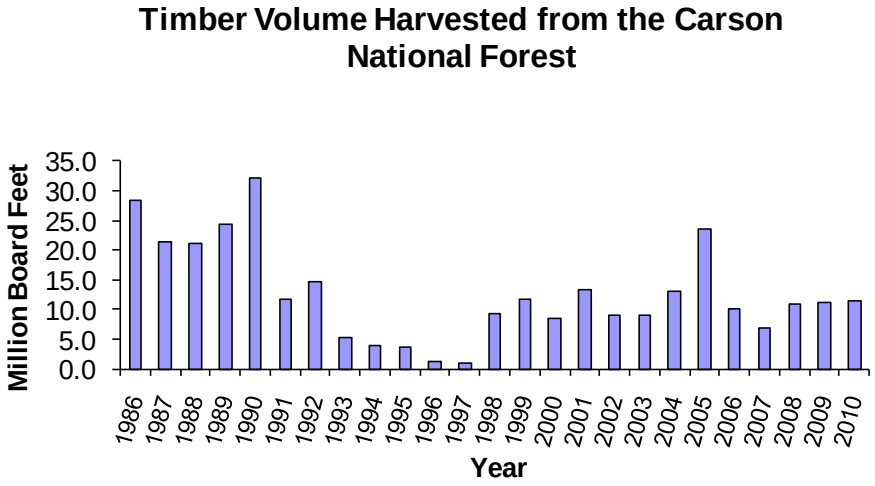


Figure 4. Timber Volume Harvested from the Carson National Forest

Elk now utilize and frequent virtually every habitat type found on the Forest. Recent habitat improvement projects such as water developments, prescribed burns, timber harvest, fuelwood sales, and the clearing of piñon-juniper woodlands have helped to distribute use, but have likely contributed to the expansion of existing herds into unoccupied habitats over the past couple of decades. **Overall, habitat condition and trend for elk on the Carson National Forest is considered fair and stable.** A downward trend is likely on high index sites, where there is rapid

forest succession and recent project work such as thinning and prescribed burning have not been implemented.

In the long term, quality habitat for elk is dependent on projects specifically designed to provide understory forage recovery, away from streams and riparian vegetation, and to improve small parks and openings through meadow maintenance and thinning near these sites. A likely habitat-population relationship between aspen stands and elk numbers in the Valle Vidal area may require special study and management in order to retain aspen habitats in that area.

POPULATION TREND

Elk are most abundantly distributed in the Intermountain West from mid-central British Columbia and Alberta south through the western states to mid-central Arizona and New Mexico. They are also found on the Coast of Washington, Oregon, and northern California, and in scattered transplanted populations in Canada and some eastern and Midwestern states.

Regional

The *NatureServe* database (www.natureserve.org/explorer) documents that throughout its range, the elk is listed as "G5", (i.e., globally secure and common, widespread and abundant). Reasons given for the G5 ranking are its large range and that it is common in many areas and there is no evidence of large-scale declines. It is not vulnerable in most of its range. Species with this rank typically occur in more than 100 localities, and there are more than 10,000 individuals. Within the United States, elk is listed as "N5" (i.e., secure and common, widespread, and abundant).

New Mexico

Due to heavy unregulated hunting in the mid to late 1800's and early 1900's, elk were extirpated from New Mexico by 1909. The following year efforts to reintroduce elk into the state began. In 1911, 12 animals from Routt County, Colorado, were released near Raton and Las Vegas, and 50 animals from Yellowstone Park were released in San Miguel County and in the Pecos area (NMDGF 2001). In 1912 there were 60 elk in New Mexico; by 1923 the northeastern herd had grown to 750; by 1934 there were 3,500 to 4,000 elk state wide.

Carson National Forest

The present Central Carson elk herd was started with two small transplants on the Tres Piedras District in 1938 and 1939. The New Mexico Department of Game and Fish (NMDGF) transplanted 14 mature elk in the Tusas Valley. Similar transplants have also occurred in southern Colorado. By 1967 the state herd was estimated at 11,000, and most of the former elk range, including that of Merriam's elk, was occupied (Findley et al. 1975). This confirms what the Forest Plan predicts of elk populations over the course of plan implementation – "…populations are expected to increase because of improved habitat condition" (USDA 1986c, p. 238).

The population trend for elk on the Carson National Forest is considered stable. The NMDGF has steadily increased hunting permits for elk, including a limited number of late season cow permits to help hold the population at desired levels and prevent depredation of hay fields on private lands. Although not necessarily a good indicator species, elk are controversial. Public perceptions tend to fall into one of two camps. The first is held by local grazing permittees and is that elk are excessively utilizing forage resources. The other is held by sportsman and hunters and to some degree NMDGF personnel and those that generally enjoy wildlife viewing. This perspective is that, while elk numbers have been reduced, cattle numbers

remain over allocated, resulting in overgrazing. It is somewhat complicated by a view that there has been undue influence over a New Mexico resource by a few grazing permittees that are not New Mexico residents. Drought conditions have heightened awareness and fueled the controversy.

One significant elk population on the forest is located on the Valle Vidal. Population numbers in this area are also somewhat controversial in relation to the long-term management of the aspen resource. Aspen regeneration is subject to both disease and consumption. Maintaining both the livestock and elk numbers will eventually result in the loss of most of the aspen throughout this unit.

In the longer-term, population objectives will be both political and resource related. Population levels will depend on maintaining healthy habitats for elk. This will also be dependent on projects specifically designed to promote understory forage recovery, away from streams, riparian vegetation, and key livestock grazing areas, so utilization by species can be more accurately monitored. The Forest will need to improve small parks and openings through meadow maintenance and thinning near these sites. Each wintering area should have a schedule established to conduct prescribed burning and maintenance.

The drop in numbers after the 1998 season partially reflects a boundary change in hunting Unit 49. The trend in elk numbers may best be reflected by the increase in hunting permits issued during the period of the Forest Plan.

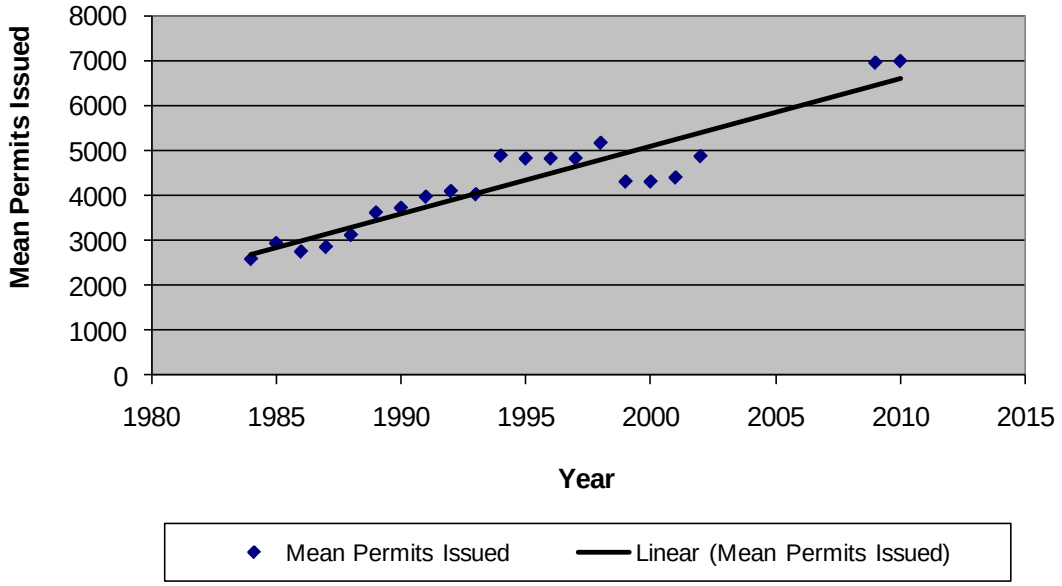


Figure 5. Elk Permits Issued All Carson National Forest Hunt Units
Note: Data for 2003 - 2008 was unavailable at the time of this report

Over the last century, elk numbers on the Carson increased (Dunn et al. 1995, Catanach et al. 1995), however current observations of year-round elk use in piñon-juniper may be an indication that elk populations are reaching a “peak” or that populations are stabilizing. Winter range encroachment from private land development and hunting success also influence population trends.

The NM Department of Game and Fish has conducted flight counts for many years, but population estimates could not be determined due to the inability to see animals in the denser cover types. It was also unknown what percentages of animals were in the open areas and actually counted, and how many were under canopy cover. As a result, a Sightability Index Survey (SIS) analysis was initiated in 1999 in selected locations to help estimate populations by Game Management Units (GMU). Sightability surveys are designed to account for animals that go unseen during survey events. In addition, the method allows for an estimate of variability to be generated and a confidence interval developed for the estimated parameters, including herd size and composition. Table 1 shows data from 1999 - 2006 from sightability surveys and modeling conducted by the New Mexico Department of Game and Fish (NMDGF 1999-2006).

Table 1. Elk Population Estimates by Game Management Unit on the Carson National Forest (NMDGF 1999 - 2006; 2009 – 2010).

Ranger District	GMU	Modeled Pop. Jan 2001	1999	2000	2001	2002	2003	2004	2005	2006	2009	2010
Jicarilla	2	1000	-	-		322	1351	-	245	-	500-1100	500-1100
Camino Real	45	1350*	-	-	1421	1395	-	-	2541	-	1665-2604	1665-2604
Camino Real	49	500	-	-	405	487	-	-	-	-	350-1030	350-1030
TP, mostly on BLM	50	550	2270**	401	-	-	1700	-	-	-	N/A	N/A
Canjilon & El Rito	51	750	554	887	-	-	1145	-	-	2497	N/A	N/A
Tres Piedras	52	3000	2799	2924	-	-	4882	-	-	-	N/A	N/A
North-central Region	4, 5B, 50, 51, 52										18060 - 22584	18060 - 22584
Questa	53	600	568	583	-	-	358	-	-	-	1610-2957	1610-2957
Questa	55A***	-	-	2575	-	-	-	-	4461	2372	N/A	N/A

* Only about 10% on Carson NF, remainder on Santa Fe NF

** Unusually high numbers due to influx of winter migration

N/A – Estimates are no longer available from NMDGF

***GMU 55A is the Valle Vidal Unit only

The Sightability Index Survey method was discontinued by New Mexico Department of Game and Fish after 2006. NMDGF determined that the surveys were very expensive, tended to overestimate populations, especially in dense forests and areas with low to medium densities, and produced highly variable results (Weybright, pers. comm. 2011). The Department now uses fall (rut period) surveys, in combination with a variety of models, to estimate population ranges. It's believed that the new method improves bull, calf, and yearling ratios and provides better data on the Elk populations hunted in each GMU (Weybright, pers. comm., 2011).

The newly estimated population ranges (2009-2010) for GMU's including all or portions of the Jicarilla, Camino Real, and Questa ranger districts either include or exceed virtually every population estimate previously developed using the Sightability Index Survey method. And,

although estimates are no longer available for the separate GMU's that overlap with the Tres Piedras, Canjilon, and El Rito districts, the population estimate for the North-central Region (that includes all of these GMU's) shows a substantial population of Elk in this area.

Taking into account the condition and trend of elk habitat on the Forest, existing data, and the continued increase in the number of hunting permits issued by the NM Department of Game and Fish, **the Carson National Forest is sustaining stable populations of elk**. Future implementation of prescribed burning, urban-interface fire projects, thinning, aspen regeneration, meadow maintenance, road closures and livestock grazing management should improve elk foraging habitat. Subsequently, these forest activities will maintain elk populations.

REFERENCES

Adams, Arthur W. 1982. Migration. In: Thomas, Jack Ward; Toweill, Dale E., eds. Elk of North America: ecology and management. Harrisburg, PA: Stackpole Books: 301-322. (Book found at Carson Forest Supervisor's Office, Wildlife Biologist)

Brown, Richard L. 1987. Effects of timber management practices on elk. A Problem Analysis Report, January 1987: Federal Aid in Wildlife Restoration Project W-78-R: Arizona Game and Fish Department. 48 p.

Cortez. 2003. Personal communication.

Dahms, Cathy W.; Geils, Brian W., tech. Eds. 1997. An assessment of forest ecosystem health in the Southwest. General Technical Report RM-GTR-295. Fort Collins, CO: US Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 97 p.

Edge, W. Daniel; Marcum, C. Les; Olson-Edge, Sally L. 1987. Summer habitat selection by elk in western Montana: a multivariate approach. Journal of Wildlife Management. 51(4): 844-851.

Findley, J.A.; Harris A.H.; Wilson, D.E.; Jones, C. 1975. Mammals of New Mexico. Albuquerque, NM: Univ. of New Mexico Press. xxii + 360 p.

Frank, Douglas A. 2004. The interactive effects of grazing ungulates and aboveground production on grassland diversity. Oecologia (2005) 143: 629-634.

Harrington, M.G.; Sackett, S.S. 1990. Using fire as a management tool in southwestern ponderosa pine. Krammes, J.S., tech. coord. Effects of fire management of Southwestern natural resources; 1988 November 15-17; Tuscon, AZ. General Technical Report RM-191. Fort Collins, CO: US Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 122-133.

Kanter, Lee Edward. 2002. Evaluating perceived resource conflicts in context with spatial dynamics of an interstate wintering elk herd. Las Cruces, NM: New Mexico State University. M.S. thesis. 88 p.

Kaye, Margot; Binkley, Dan; Stohlgren, Thomas. 2005. Effects of conifers and elk browsing on quaking aspen forests in the central Rocky Mountains, USA. Ecological Aplications (2005). 15(4): 1284-1295.

Kohlmann, Steve. 2006. Personnel communication with Carson NF biologist at annual Northeast Area coordination meeting between NMDGF, Forest Service, and BLM

Leege, Thomas A., compiler. 1984. Guidelines for evaluating and managing summer elk habitat in northern Idaho. [Wildlife Bull. No. 11]. Boise, ID: Idaho Fish and Game. 37 p. [A cooperative effort. Financial support provided by the Idaho Department of Fish and Game

Federal Aid Project W-160-R, U.S. Forest Service, Bureau of Land Management, Plum Creek Timber Company and Idaho Forest Industry Council].

Lyon, L. Jack. 1979. Habitat effectiveness for elk-as influenced by roads and cover. Journal of Forestry (October 1979): 658-660.

Lyon, L. Jack. 1985. Elk and cattle on the National Forests: A simple question of allocation …or a complex management problem? Western Wildlands (Spring 1985). 11(1): 17-19.

Lyon, L. Jack; Christensen, Alan G. 1992. A partial glossary of elk management terms. General Technical Report INT-288. Ogden, UT: US Department of Agriculture, Forest Service, Intermountain Research Station. 6 p.

Miller, William H; Brock, John H.; Horsley, James. 1995. Elk-cattle interaction in central Arizona. Final Report, 6 November, 1995: Submitted to Rocky Mountain Elk Foundation, Arizona Game and Fish Dept., and USDA Forest Service (Coconino National Forest). Tempe, AZ: Arizona State University. 72 p.

Moir, W.H.; Fletcher, R.A. 1996 Forest diversity in New Mexico. New Mexico Journal of Science. 36: 232-254.

Moore, M.; Deiter, D. 1992. Stand density index as a predictor of forage production in northern Arizona pine forests. Journal of Range Management. 45: 267-271.

NatureServe Explorer: An online encyclopedia of life [web application]. 2010. Version 7.1. Arlington, Virginia, USA: NatureServe. Available: http://www.natureserve.org/explorer. (Accessed: March 15, 2011).

New Mexico Department of Game and Fish. 1971. Elk population trends, distribution, and harvest information: September 1, 1969 to May 30, 1970. Project No. W-93-12. Santa Fe, New Mexico: NM Department of Game and Fish.

New Mexico Department of Game and Fish. 1987. 1987 northeast area helicopter surveys. Santa Fe, New Mexico: NM Department of Game and Fish.

New Mexico Department of Game and Fish. 1988. Elk winter aerial surveys unit 52: 1983-1988. Santa Fe, New Mexico: NM Department of Game and Fish.

New Mexico Department of Game and Fish. 1992. 1992 winter aerial survey results. Santa Fe, New Mexico: NM Department of Game and Fish.

New Mexico Department of Game and Fish. 1995a. Long range plan for management of New Mexico's elk 1995-2002. New Mexico wildlife management. Santa Fe, New Mexico.

New Mexico Department of Game and Fish. 1995b. Big game surveys: elk population trends, distribution and harvest information. Final Report, 1 April, 1989: NM W-093-R-37/Job 2/Segments 32-36. Santa Fe, NM: New Mexico Department of Game and Fish. 26 p.

New Mexico Department of Game and Fish. 1995c. Big game surveys: Valle Vidal elk studies. Final Report, 1 April, 1989: NM W-093-R-36/Job 3/Segments 32-36. Santa Fe, NM: New Mexico of Game and Fish. 46 p.

New Mexico Department of Game and Fish. 1995d. Big game surveys: data analysis and interpretation. Final Report, 8 August, 1994: NM W-093-R-36/Job 17/Segment 36. Santa Fe, NM: New Mexico of Game and Fish. 20 p.

New Mexico Department of Game and Fish. 1997a. Elk harvest surveys: 1996-1997. Santa Fe, New Mexico: NM Department of Game and Fish.

New Mexico Department of Game and Fish. 1997b. Aerial survey summary: 1993-1997. Santa Fe, New Mexico: NM Department of Game and Fish.

New Mexico Department of Game and Fish. 1998. Elk harvest surveys: 1997-1998. Santa Fe, New Mexico: NM Department of Game and Fish.

New Mexico Department of Game and Fish. 1999. Elk survey data by year: 1981-1999. Santa Fe, New Mexico: NM Department of Game and Fish.

New Mexico Department of Game and Fish. 2000a. Elk hunter report: 1999-2000. Santa Fe, New Mexico: NM Department of Game and Fish.

New Mexico Department of Game and Fish. 2000b. 2000 elk hunter report: GMU summary. Santa Fe, New Mexico: NM Department of Game and Fish.

New Mexico Department of Game and Fish. 2000c. 2000 elk and deer sightability index survey analysis. Federal aid in wildlife restoration grant W-93-R41, Projects 1.1.1 and 1.2.1. Santa Fe, New Mexico: NM Department of Game and Fish: 54 p.

New Mexico Department of Game and Fish. 2001a. State of New Mexico elk population units. Santa Fe, New Mexico: NM Department of Game and Fish.

New Mexico Department of Game and Fish. 2001b. 2001 elk and deer sightability index survey analysis. Federal Aid in Wildlife Restoration Grant W-93-R42, Projects 02.01 and 02.02. Santa Fe, New Mexico: NM Department of Game and Fish: 67 p.

New Mexico Department of Game and Fish. 2003. Carson National Forest elk numbers: 1984-2003. Santa Fe, New Mexico: NM Department of Game and Fish.

New Mexico Department of Game and Fish. 2004. BISON-M (Biota Information System of New Mexico): Biological database for New Mexico. NMDGF in cooperation with USDI BLM, USDI FWS, USDI Bureau of Reclamation, US Army Corps of Engineers, USDA Forest Service and University of New Mexico. http://fwie.fw.vt.edu/states/nmex_main/species/050215.htm. (Accessed: March 19, 2006).

New Mexico Department of Game and Fish. 2005. Summary of elk information by game unit on the Carson National Forest: Personal communication between Chirre Keckler (Forest Biologist) and Darrel Weybright (Big Game Programs, NMGF).

Peek, James M.; Scott, Michael D.; Nelson, Louis J. [and others]. 1982. Role of cover in habitat management for big game in northwestern United States. Transactions, 47th North American Wildlife and Natural Resources Conference. 47: 363-373.

Rowland, Mary M.; Wisdom, Michael J.; Johnson Bruce K.; Penninger Mark A. 2004. Effects of roads on elk: implications of management in forest ecosystems. Transactions of the sixth-ninth North American Wildlife and Natural Resources Conference: Resource stewardship in the 21st century; a voyage of re-discovery: March 15-20, 2004. Spokane, Washington, Washington DC, Wildlife Management Institute, c2004: pp. 491-508.

Sandoval, Leonard; Holecheck, Jerry; Biggs, James; Valdez, Raul; VanLeeuwen, Dawn. 2005. Elk and mule deer diets in north-central New Mexico. Rangeland Ecology (July 2005). 58: 366-372.

Severson, Keith E.; Medina, Alvin L. 1983. Deer and elk management in the southwest. Journal of Range Management Monograph. No. 2. 64 p.

Skovlin, Jon M. 1982. Habitat requirements and evaluations. In: Thomas, Jack Ward; Toweill, Dale E., eds. Elk of North America: ecology and management. Harrisburg, PA: Stackpole Books: 369-414.

Smallidge, Samuel; Thompson, Bruce; Gould, William. 1999. Spatial dynamics, conflict evaluation, and demographics for elk that winter near San Antonio Mountain, New Mexico. Performance Report October 1998 - June 1999. Federal Aid in Wildlife Restoration Grant, Project W-136-R. Santa Fe, New Mexico: NM Department of Game and Fish: 11 p.

Smallidge, Samuel; Thompson, Bruce; Gould, William. 2000. Spatial dynamics, conflict evaluation, and demographics for elk that winter near San Antonio Mountain, New Mexico. Performance Report July 1999 - June 2000. Federal Aid in Wildlife Restoration Grant, Project W-136-R. Santa Fe, New Mexico: NM Department of Game and Fish: 19 p.

Smallidge, Samuel; Thompson, Bruce; Gould, William. 2001. Spatial dynamics, conflict evaluation, and demographics for elk that winter near San Antonio Mountain, New Mexico. Performance Report July 2000 - June 2001. Federal Aid in Wildlife Restoration Grant, Project W-136-R3. Santa Fe, New Mexico: NM Department of Game and Fish: 19 p.

USDA Forest Service. 1996. Record of decision for amendment of forest plans – Arizona and New Mexico. Albuquerque, NM: US Department of Agriculture, Forest Service, Southwestern Region. 96 p.

USDA Forest Service. 2000. Why do elk seek shelter?: The case against the need for thermal cover. Science Findings (February 2000): 22. Portland, OR: US Department of Agriculture, Forest Service, Pacific Northwest Research Station. 5 p.

USDA Forest Service. 2002. Fire Effects Information System, [Online]. Available: http://www.fs.fed.us/database/feis/. Fort Collins, CO: US Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory.

Urness, Phillip. 1985. Elk nutrition and foraging behavior. In Workman, G.W., ed. Western elk management: a symposium; Logan, UT: Utah State University: 161-169.

Wisdom Michael J.; Cimon Norman J.; Johnson Bruce K.; Garton Edward O.; Thomas Jack Ward. 2004a. Spatial partitioning by mule deer and elk in relation to traffic. Transactions of the sixth-ninth North American Wildlife and Natural Resources Conference: Resource stewardship in the 21st century; a voyage of re-discovery: March 15-20, 2004. Spokane, Washington, Washington DC, Wildlife Management Institute.

Wisdom, M.J.; Preisler, H.K.; Cimon, N.J.; Johnson, B.K. 2004. Effects of off-road recreation on Mule Deer and Elk. Transactions of the North American Wildlife and Natural Resource Conference 69: in press.

CARSON NATIONAL FOREST MANAGEMENT PLAN DIRECTION FOR ELK

The following is for Rocky Mountain elk taken from the Carson Forest Plan (USDA 1986c, Wildlife & Fish).

BIG GAME SUMMER RANGES… On big game summer ranges manage suitable timberlands to achieve a diversity of vegetative conditions by balancing timber age and canopy cover classes.

COVER NEEDS… On primary big game winter ranges and primary calving and fawning areas, manage to achieve identified cover requirements to meet big game population goals and objectives. The remaining suitable timberlands will be manage to provide habitat diversity.

EDGE CONTRAST… Maintain at least a medium amount of edge contrast between stands and cutting units created by even-age management. This means that cutting units prescribing regeneration cuts shall be placed at least 75 percent of the time adjacent to stands which will result in at least two age class difference after treatments, unless stands are being regenerated to manage aspen or to correct insect and disease or other natural catastrophes.

SUMMER BIG GAME COVER...

Diversity units dominated by forested vegetation types, including piñon-juniper will be managed so that no less than 40 percent summer big game cover will be maintained over time.

Diversity units dominated by non-forested vegetation types will be managed to minimize impacts to summer big game cover. The standards in Table 4 will apply.

Table Wildlife - 4. Forage Cover Ratios

% of Unit with Forest Vegetation	% of Forested Area in Cover
35 -50%	At least 60%
20 -34%	At least 75%
Less than 20%	At least 90%

SUMMER BIG GAME THERMAL COVER… On suitable timberlands manage for no less than 10 percent summer big game thermal cover within each diversity unit. The allocation of thermal cover will be stands of at least 30 acres in the sapling-pole stage or older, with canopy closures of 70 percent or greater. Stands on north-facing aspects should receive priority in the allocation of thermal cover.

SUMMER BIG GAME HIDING COVER...

- *Manage suitable timberlands, and piñon-juniper, so that no less than 10 percent hiding cover is maintained on big game summer ranges that occur within each diversity unit. Stands allocated for cover should have at least a 450-foot radius from the stand center to any point on the exterior perimeter (approximately 20 acres).*
- *In forested management areas, including piñon-juniper, the objective will be to maintain summer big game hiding cover on 60 percent or more of the perimeter of all natural and created openings, and along at least 75 percent of the edge of arterial and collector roads.*

- *Summer big game hiding cover will be maintained or improved adjacent to special features (seeps, springs, wet meadows, wallows, salt licks, water developments). The following standards will apply:*
  - ✓ Timber cutting within a minimum radius of 300 feet of the feature will be accomplished only if big game cover can be maintained or improved.
  - ✓ Cutting unit boundaries will be designed so that at least one third of the perimeter around the feature is contiguous to adjacent forest cover.
  - ✓ Permanent roads will not be constructed within 200 feet of special features unless there is no feasible alternative to build the road in another location.
  - ✓ Temporary roads will not be constructed within 100 feet of special features.
  - ✓ Skidding equipment will be authorized to within 75 feet of the feature and logging debris removed from all trails leading to the feature.
- *Forested areas, including piñon-juniper, within at least 1200 feet of primary big game winter and calving and fawning forage areas, will be managed to maintain or improve the integrity of hiding and thermal cover.*

All other summer range cover standards and guidelines will apply to winter ranges and big game calving and fawning areas.

BIG GAME COVER... Big game cover requirements may be reduced temporarily during periods when stands are being regenerated to meet cover standards, to correct tree disease, to rejuvenate aspen stands, or where windthrow or wildfire has occurred.

BIG GAME HIDING AND THERMAL COVER LEVELS... In planning for the cover requirements of big game on each diversity unit utilize Table 5 *[Table not shown in this document]* in conjunction with available timber stand data. Refinement of the stand conditions suitable to meeting cover requirements will be made as a result of field verification on an individual stand basis. As specific information is developed on the Forest this table *[Table not shown in this document]* may be modified if needed to reflect the appropriate range of cover conditions.

TIMING, SIZE & PERIOD OF TIMBER MANAGEMENT ACTIVITIES:

DISPLACEMENT... Minimizing the displacement of big game and other sensitive wildlife, and providing sufficient security areas will be emphasized in the planning and implementation of the Forest-wide timber sale program.

ACTIVITIES NOT ADJACENT... The objective will be to arrange timber sales over time and space so that concurrent activities do not occur adjacent to one another. Manage adjacent areas at least as large as the affected area of activity for wildlife security habitat.

ACTIVITIES WITHIN DRAINAGES... When designing timber sales attempt to keep activity perimeters within one major drainage at a time. Utilize subdivision design and contract stipulations (such as requiring the completion of a block before beginning activities in another area of the sale) as necessary to minimize impacts on security habitat.

THREE YEAR LIMIT... Timber sales will be designed so that activity time frames will minimize displacement of wildlife. A primary objective will be to limit logging disturbance in an activity area to no more than three years whenever possible on each timber sale.

WINTER LOGGING... On big game summer ranges where winter logging operations are environmentally and economically feasible encourage operations during this period.

SEASON LIMITS...

- *On primary big game winter ranges timber management activities, including timber sale preparation, logging, timber stand improvement, and brush disposal will be authorized only during the period April 15 - December 15.*
- *Within identified turkey nesting areas timber management activities will not be authorized during the period April 15 - June 30.*
- *Within primary big game calving and fawning areas timber management activities will not be authorized during the period May 1 - July 25.*

ROAD MANAGEMENT/WILDLIFE INTEGRATION:

ROAD MANAGEMENT... Emphasize road management and resource/wildlife protection as a primary Forest policy. Focus media attention on road management at least biannually, especially management to provide wildlife security and reduce impacts to soil, water and fisheries.

MIGRATION ROUTES... Do not construct permanent roads across major big game migration routes unless no feasible alternative exists, as determined by interdisciplinary team review.

ROAD DENSITIES... Road management will provide for an environment relatively free from human disturbances to wildlife. Manage over time to achieve the following guidelines for maintaining or improving effective big game habitat:

Summer big game range: 60% habitat effectiveness (approximately 1.0 mile/square mile of roads open to public use).

Winter big game range: 75% habitat effectiveness (approximately .5 mile/square mile of roads open to public use during the period December 15 -April 15).

Primary winter big game forage and associated cover areas: 90% habitat effectiveness (approximately .1 mile/square mile of roads open to public use during the period December 15 -April 15).

EFFECTIVE CLOSURES... Whenever possible, design roads so they can be easily and effectively closed (either permanently or temporarily) at a low cost.

AVOIDANCE AREAS... Permanent roads will be designed to avoid saddles, meadows, ridge tops, and riparian areas whenever economically and physically possible.

CLOSURES... Install gates or other effective closure methods at onset of road building activity when the objective is to prevent human use patterns from becoming established. Closures will be implemented during any period of inactivity exceeding 24 hours. During big game hunting seasons closures will be implemented full-time if necessary to provide additional wildlife security areas.

SIGNING... Include signs where appropriate on gates and other closure devices indicating the reasons for and dates of all road closures.

CLOSURE TIME FRAMES... All local terminal roads will be completely closed to public use by no later than two years following completion of a timber sale contract. All other temporary roads will be closed and/or obliterated upon completion of the activity.

BIG GAME WINTER RANGE & FORAGE/COVER AREAS... On big game winter ranges authorize new permanent road construction only if needed to meet priority objectives outside the winter range, as determined by interdisciplinary team review. Minimize impacts by locating roads outside of identified primary forage and cover areas.

CALVING AND FAWNING AREAS... Locate new arterial, collector and local service roads outside of primary big game calving and fawning areas. Close other roads as needed during periods of calving and fawning activity May 1 - July 25.

TRAVEL MANAGEMENT/WILDLIFE INTEGRATION:

The following wildlife-related criteria will be used to evaluate the need for future travel closures and restrictions including over-the-snow vehicles:

Habitat for threatened, endangered, or sensitive species is threatened. .

Meadows and other forage areas likely to be, or being damaged.

Key wildlife areas being threatened or damaged.

Areas important to wildlife reproduction, such as calving and nesting areas, where disturbance is causing, or likely to cause, significant stress and/or reduction of reproductive success.

Important seasonal security areas, such as big game winter ranges, where disturbance would result in significant displacement and/or loss of habitat values.

Riparian areas which are being threatened or damaged.

RANGE/WILDLIFE INTEGRATION:

RANGE MANAGEMENT PLANS... Design range management systems and plans with input from State and Federal wildlife biologists to minimize conflicts with fish and wildlife. Whenever possible design grazing systems to minimize domestic livestock impacts on important seasonal wildlife ranges such as primary calving and fawning areas, winter ranges, and primary turkey nesting areas.

SALT... Livestock salt shall not be placed in or adjacent to any riparian area or other identified key wildlife area where degradation of wildlife habitat would be likely to occur.

FORAGE ALLOCATION... Wildlife will be allocated forage on the basis of mutually agreed-upon population goals and objectives of the Forest Service and New Mexico Department of Game and Fish.

WATER... During summer months, where free water has been identified as limiting desired wildlife population levels, maintain water in livestock troughs for wildlife use after domestic animals have been removed from the grazing unit. In winter months on identified primary big game winter ranges, provide water where freezing will not damage existing facilities, or install bubblers or other devices to prevent freezing.

WILDLIFE/FENCE CONFLICTS... Install let down fences, top-rail fences, barbless bottom wire, or elk jumps wherever necessary to reduce wildlife/fence conflicts. On newly constructed fences the bottom wire will be at least 18 inches above the ground, and the top wire will be at least 38 inches, but no more than 42 inches above the ground. Do not construct new net wire fences on identified pronghorn ranges and modify existing fences as needed to provide for seasonal movement of pronghorn.

RIPARIAN WOODY VEGETATION... On wet meadows and other riparian areas, favor the establishment of woody riparian vegetation as defined in FSH 2509.23. Control livestock and wildlife grazing through management and/or fencing to allow for adequate establishment of vegetation and the elimination of overuse.

SEEDING FOR DIVERSE VEGETATION... Vegetative treatments which require seeding will utilize a mix of plant species which will result in increased plant cover and improved quality and diversity of forage for both wildlife and livestock.

OTHER WILDLIFE AND FISH PLANNING AND HABITAT IMPROVEMENT:

HABITAT IMPROVEMENT PROJECTS... Plan for, and include game/nongame wildlife and fish habitat improvement projects in sale area improvement plans for all timber sale areas including piñon-juniper, where there is a potential to improve wildlife and fish habitat conditions.

RECORDS... Identity and maintain records of important wildlife and fish habitats and integrate wildlife and fish requirements through interdisciplinary team review of all planned programs and activities occurring on National Forest System Lands.

WILDLIFE AND FISH OBJECTIVES... Provide wildlife and fish objectives and expected outputs throughout the integrated resource management process for commercial timber sales and other proposed management activities. Identity, on a diversity unit or herd unit basis, wildlife and fish habitats necessary to meeting identified objectives, as stated throughout Forest wide and management area standards and guidelines.

WATER IS LIMITING... Identify areas of the Forest where the lack of dependable water is a limiting factor. Determine priority areas and schedule wildlife water improvements including, but not limited to, spring developments, trick tanks, vertical and horizontal water wells, and earthen tanks. Wildlife water developments will be fenced if needed to exclude livestock and wild horse use. Top-rail fences will be installed as necessary to minimize wildlife injuries and to reduce the need for yearly maintenance.

Wild Turkey

INDICATOR SPECIES HABITAT

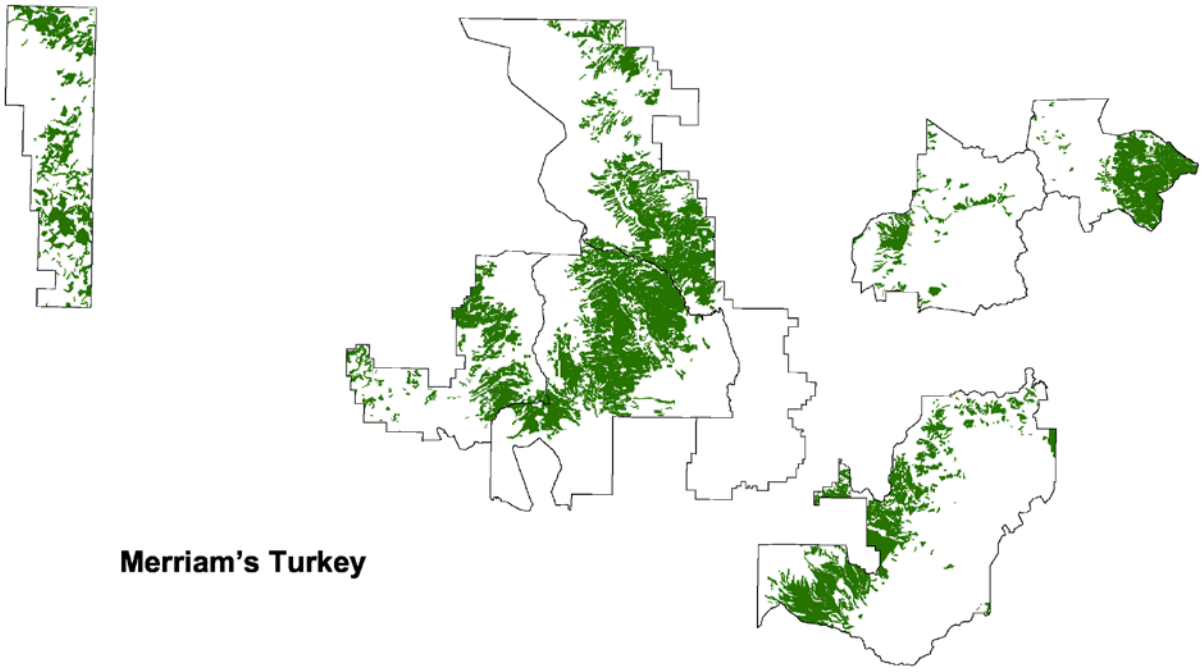
The wild turkey is an indicator species for the presence of old growth pine (USDA 1986a, p.97). Merriam's turkeys (*Meleagris gallopavo merriami*) are common in most mountainous areas of New Mexico and across the west (Kennamer et al. 1992). This upland game bird primarily utilizes ponderosa pine and pine-oak as well as the transition habitats between ponderosa and piñon-juniper woodland habitats and ponderosa and mixed conifer. There are three essential habitat components. These include surface water, roosting trees, and openings for summer brood areas (Kamees 2002). Turkeys often key in on old growth habitats as they generally provide a combination of cover, roosting, and summer brood habitats.

The Merriam's turkey is one of five recognized subspecies of wild turkey. Three of which occur in New Mexico. Merriam's has the widest distribution and is among the most common of the subspecies. Its range is generally considered to be the eleven western states, including northern New Mexico and the Carson National Forest (Kamees 2002). It is common in most mountainous areas of New Mexico.

Ponderosa pine habitats provide a source of mast crop, roosting trees, and productive openings for brooding (NMDGF 2011). Turkeys prefer to roost in tall mature or over-mature ponderosa pines with relatively open crowns and large horizontal branches starting at 6 to 9 meters (20-30 ft) from the ground. Trees with a diameter at breast height (DBH) of over 14 inches are used as roosts. Preferred roost sites are often located just below a ridgeline. Hens normally nest within ½ mile radius of water (Boeker and Scott 1969; Hoover 1987).

A healthy ponderosa pine understory provides cover, as well as, forage. Turkeys forage in grasslands, brush communities, deciduous tree-brush, and in ponderosa pine. They eat grasses and some forbs and insects such as grasshoppers in the summer (Hoover 1987). Oak acorns, mature ponderosa pine seeds and piñon pine nuts supply an important mast crop in the fall (Shaw and Mollohan 1992). Taller grasses are important in the winter during heavy snow packs. Openings with adequate residual forage height and abundant insects are important to hens with broods. Young poults are heavily dependent on insects for the first couple of weeks and residual stubble height is important for cover.

The Carson Forest Plan focuses on old growth, specifically as it relates to available roost tree habitat as a basis for MIS habitat. The Forest Plan estimates 117,300 acres of habitat for wild turkey. The vegetation stand cover data was used to produce the potential habitat distribution map. There is some degree of occupancy distributed across most of these habitats. With this in mind, some treatments, such as group selections in adjacent mixed conifer stands can be just as beneficial for this species as those in the ponderosa pine. The vegetation layer indicates the Carson National Forest has 301,297 total acres of ponderosa pine.



Map 1. Wild Turkey Potential Habitat Distribution on the Carson National Forest (USDA 1987)

Management Activities or Natural Events That May Affect Habitat

Negative: Primarily related to long term cumulative effects of forest succession after heavy logging, long-term fire suppression, some overstory removal prescriptions, drought and large wildfires.

Positive: Thinning, water developments, road closures, prescribed fire and small wildfires.

Plans, Regulations and Guidelines Supporting Habitat Protection

- *Carson National Forest Land and Resource Management Plan, Forest-wide Wildlife and Fish* and Management Areas 3, 4 and 5 -- desired condition is to provide quality habitat for wild turkey. Objective of prescribing annually fire on 1,000 acres of this habitat type. (USDA 1986c)
- *New Mexico Hunting Proclamation*

HABITAT CONDITION AND TREND ON THE CARSON NATIONAL FOREST

There are two levels that need to be considered when looking at the wild turkey habitat across the Forest. First, is the overall ponderosa pine habitat. This is important to help place the subset of old growth identified for wild turkey in the Forest Plan EIS in perspective. Although there are 301,297 total acres of ponderosa (based on current stand data cover types), the Forest Plan EIS identifies a subset of 117,300 acres of occupied turkey habitat. According to the Forest Plan EIS, wild turkey utilize old growth stands of pine, but focus on roost tree availability as a key component or habitat group (USDA 1986a, p. 97). Although definitions for old growth have changed somewhat since 1986, there was and still is significantly less than 117,300 acres of old growth ponderosa pine on the Forest. By going back to some of the supporting documentation for the EIS, it was discovered that acres of turkey habitat were also taken from several "analysis

areas" including aspen and mixed conifer. The ponderosa pine roost tree component can and does occur in some of these habitats. Since that time, stands have grown, some have been harvested, and some have experienced wildfire. Data to estimate habitat availability has also improved. Although there is important forest-wide data, the subset of roost trees is the primary feature by which habitat trend for wild turkey is tracked. Queries were designed to replicate to the degree possible the intent of the Forest Plan by identifying stands – including those classified as ponderosa pine, mixed conifer, or aspen – with a high likelihood of providing roost trees or roost tree groups.

Several factors are used to determine habitat trend. Management activities (primarily timber harvest) and wildfire have reduced certain habitats to unsuitable conditions. High intensity wildfire and certain harvest prescriptions such as overstory removal, seed cuts, and shelterwood harvests are examples of areas that are deducted from the total acres of turkey habitat. Total stand acres are not deducted. Only the actual acres treated that are estimated to result in acres becoming unsuitable are subtracted. Appendix A explains in more detail how habitat trend is determined.

Suitable stands (4,000 ac) that had experienced high intensity fire were removed from turkey habitat. Suitable habitat altered by timber harvest (10,813 ac) was deducted as well. Also taken into account is forest succession, where ponderosa pine stands have progressed towards more quality habitat since 1986. A conservative estimate of stands moving to suitability is one percent of the overall ponderosa pine on the Forest.

Table 1. Turkey Suitable Habitat Acres: Change from Wildfire, Logging, and Tree Growth 1986-2011

Ranger District	Total PP MC & AA Acres	Estimated Acres of Turkey Habitat	Habitat Acres Reduced by Wildfire	Habitat Acres Reduced by Logging	Total Acres Reduced	Total Acres of Ingrowth	Remaining Acres of Turkey Habitat
D1, D2, D6[1]	298,792	71,809	1,000	N/A	N/A	1,122	N/A
D3	35,848	12,016	0	N/A	N/A	188	N/A
D4	193,069	31,670	0	N/A	N/A	495	N/A
D7	131,752	15,500	3,000	N/A	N/A	242	N/A
Total	659,461	130,995	4,000	10,813	14,813	2,047	118,229

*Numbers for habitat acres reduced by wildfire are through 2007; N/A: Unavailable

Turkey habitat from 1986 to 2011 is estimated to have increased from 117,300 (per the 1986 Forest Plan) to 118,229 acres or a slight upward trend of about 1 percent.

[1] D1 = Canjilon, D2 = El Rito, D3 = Jicarilla, D4 = Camino Real, D6 = Tres Piedras, D7 = Questa

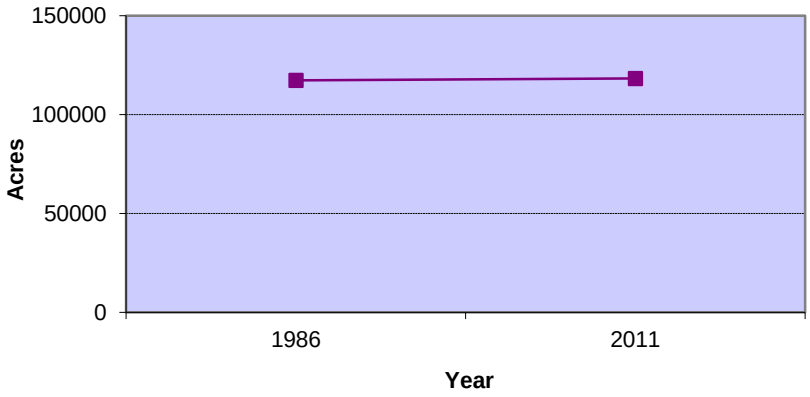


Figure 1. Changes in Turkey Suitable Habitat on the Carson National Forest from 1986 to 2011

Forest Management Activities

In the mid-elevation portions of the Carson National Forest, wild turkey habitat is abundant and well distributed, but is fairly heavily dominated by mid-seral conditions. This is not as beneficial as a good balance of habitat conditions including early and late seral stages. The dominant mid-seral conditions primarily relate to cumulative effects of historic logging, such as the railroad logging early in the 20th century and fire suppression. Duff layers in the understory not subjected to periodic burning suppress turkey forage base. Overstory removal prescriptions also contributed to the trend towards dense smaller diameter stands.

Reduction of stand heterogeneity and landscapes dominated by the vegetation structural stage (VSS) class 3 and 4 conditions has likely had a negative effect on turkey habitat. Nest sites are generally located along edges of small forest opening or near streams. Preferred nest sites have good stands of residual grass situated close to water. Good brood-rearing ranges are essential for turkeys. Such ranges are characterized by small forest openings less than five acres in size with good mixtures of grasses and forbs. Tall, dense, escape cover must be available nearby until the poults are able to fly. Similar ground cover under open canopies is also used for brood rearing (Hoover 1987).

Recent changes in management practices on the Carson National Forest places more emphasis on thinning, prescribed burning, and timber harvest objectives to meet a desired ecological condition. Thinning, group selection, and prescribed burning will all help move the VSS 3 and 4 stands towards larger and more diverse structural stages faster (Reynolds et al. 1992). The development of small openings in ponderosa pine stands for goshawks should also benefit turkeys.

Wakeling and others (1998) show where silvicultural practices may influence populations of nesting turkeys in two ways: 1) by changing habitat so that it is selected or avoided for nesting or 2) by creating habitat conditions that affect nesting success. They speculate that silvicultural management options that result in the avoidance of habitat may be less detrimental to turkey populations than those that result in less productive habitat through poorer nest success. The retention of greater numbers of larger diameter trees and the avoidance of timber treatment in areas where nesting habitat is limited could help in ensure suitable, productive nesting habitat is available (Wakeling et al. 1998). Selective cutting does not appear to adversely affect the quality of nesting habitat or nest success and pine logging slash has been substituted for nesting cover (Liedlich et al. 1991).

Other activities that could affect the turkey nesting habitat are those that reduce horizontal screening cover. Prescribed burning may reduce the productivity of that habitat component for nesting turkeys until nesting habitat is returned to pre-treatment screening cover (Wakeling et al. 1998). However, prescribed fire can play an important role in enhancing habitat, especially for broods, by: 1) opening up understory vegetation through the removal of thick shrub growth and 2) stimulating grass, forb, and legume production (Kamees 2002).

Heavy grazing is not good for turkey habitat since turkeys rely on grasses for food and cover, however, sound grazing practices are compatible with turkey range (Werner et al 1978). Moderate grazing (rest-rotation systems) can stimulate herbaceous growth and associated insect biomass, thereby, improving brood habitat as well as year-round adult feeding areas (Kamees 2002).

In some areas that would otherwise be good quality turkey range, water is either lacking or only seasonally present, and this limits local populations. Artificial water developments may assist population growth and range expansion. A good rule of thumb is to have free water available on every square mile to maximize utilization of suitable habitat (Kamees 2002). The Forest Service has actively been working with the NM Department of Game and Fish (NMDGF) and other partnerships to install water sources across the Forest.

The shift in management practices to increased thinning and prescribed burning should improve conditions favorable to increasing turkey populations over time. The urban-interface fuels reduction projects planned for the near future on the Carson will continue to improve conditions for the bird, although at a fairly slow rate. Thinning to create clumpy conditions interspersed with openings can reduce competition and create larger tree diversity for roosting and openings for foraging. Prescribed fire would control dense tree reproduction and provide understory forage. Continued development of small, protected water sources and implementation of effective road closures in turkey habitat will also improve conditions. Subsequently, these forest activities will contribute to maintaining turkey populations.

The Forest Service has conducted habitat improvement projects for turkey, including water developments, underburning in ponderosa and creating slash piles for nesting structure and thinning in dense pole stands to promote future habitat conditions.

POPULATION TREND

The Merriam's turkey has the widest distribution and is the most common subspecies of wild turkey. It is found in many mountainous areas of northern New Mexico. However, when miners and stockmen came into New Mexico in the 1800s, they started to effectively kill turkeys. Wagonloads were hauled to market. Subsequently, turkeys were eliminated from many mountain ranges and their populations depleted. The ebb was around 1924 when sportsmen began actively promoting hunting regulations and bag limits. By 1930, efforts by the NMDGF began to turn the numbers around. Birds have been live-trapped and moved to other areas (NMDGF 2011).

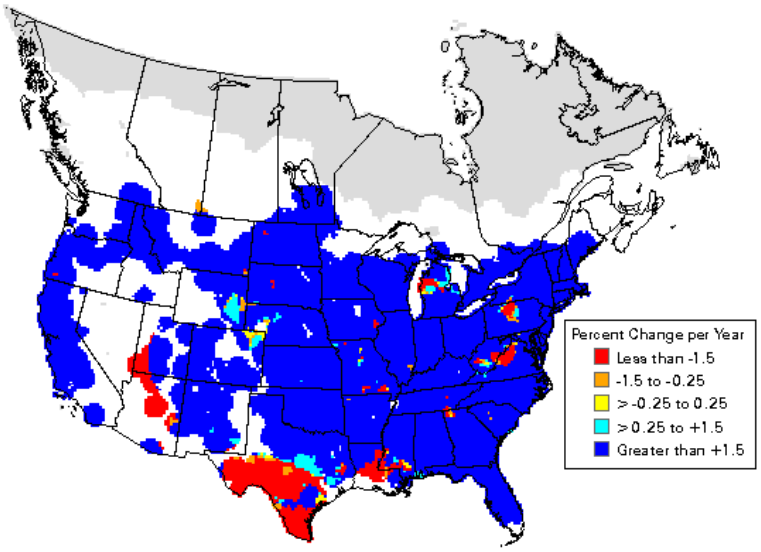
Regional

The NatureServe database (www.natureserve.org/explorer) documents that throughout its range, wild turkey is listed as "G5", (i.e., globally secure and common, widespread and abundant). Reasons given for the G5 ranking are its large range and that it is common in many areas and there is no evidence of large-scale declines. It is not vulnerable in most of its range. Species with this rank typically occur in more than 100 localities, and there are more than

10,000 individuals. Within the United States, the wild turkey is listed as “N5” (i.e., secure and common, widespread and abundant) (NatureServe 2010).

The wild turkey is not on US Fish and Wildlife Service’s list of bird species of concern for Bird Conservation Region #16 (Southern Rocky Mountains) (USDI 2008) or listed as a species of concern under the Endangered Species Act. The overall goal of the *Birds of Conservation Concern 2008* document is to accurately identify the bird species that represent the highest conservation priorities and conservation action outside of Federally listed species (USDI 2008).

Population trend data can be gathered over large areas. Wild turkey is one of the bird species for which data is collected and compiled on a large-scale breeding bird survey (BBS) of North American birds. This BBS is maintained by the Patuxent Research Center (US Geological Survey) and is found on a website (http://www.mbr-pwrc.usgs.gov/bbs). It is a roadside survey, primarily covering the continental United States and southern Canada, although survey routes have recently been initiated in Alaska and northern Mexico. The BBS was started in 1966, and the over 3,500 routes are surveyed in June by experienced birders.



Map 2. BBS Trend Map, 1966 – 2003 (Sauer et al. 2011)

The primary objective of the BBS has been the estimation of population change for songbirds. However, the data have many potential uses, and investigators have used the data to address a variety of research and management objectives (Sauer 2011). From 1966 – 2007, the population trend of the wild turkey in the southern Rockies of the United States has increased about 7.8 percent per year (Sauer et al. 2011).

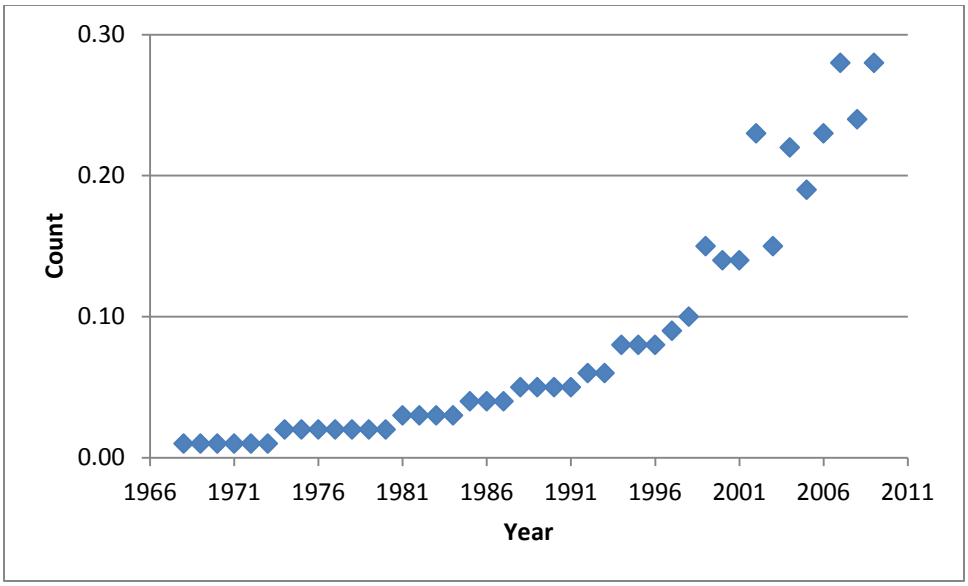


Figure 2. Population Trend of Wild Turkey in Southern Rockies from 1968 to 2009 (Sauer 2011)

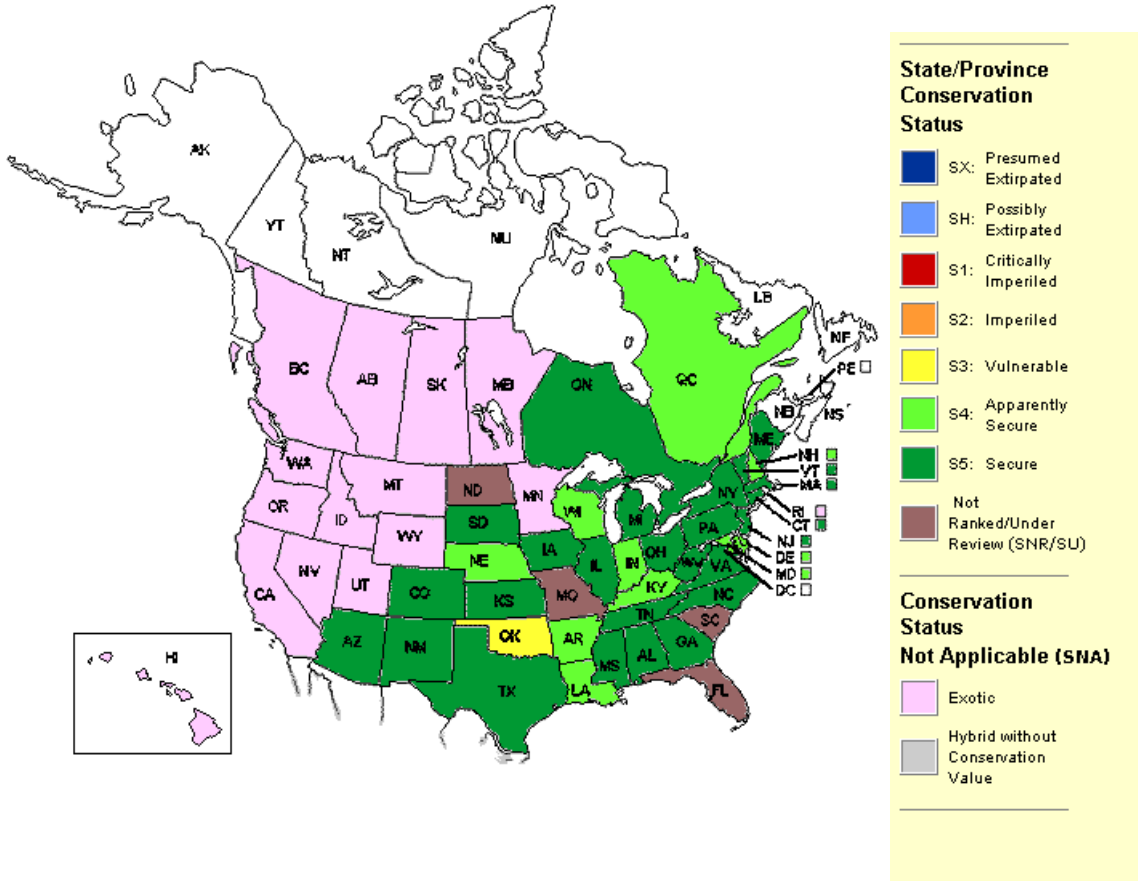
New Mexico

As discussed at the beginning of this section, wild turkey populations were affected by overhunting in the late 1800's into the early 1900's. The lowest turkey numbers were seen around 1924 (Kamees 2002). Trap and transplant operations were instrumental in the restoration of turkey populations throughout the United States and most areas of New Mexico. Most mountain ranges in New Mexico now support healthy, self-sustaining wild turkey populations (NMDGF 2011; Kamees 2002).

Harvest surveys and brood surveys have been conducted to index population trends. Harvest surveys are still conducted; however brood surveys have not continued since 1988. The general statewide turkey population trend between 1920's and 1950's was steadily upward based upon hen to poult ratio data collected annually. This information provided an estimate of annual reproduction. Between 1959 and 1990, field observation data suggest a stable population between 25,000 and 30,000. Since 1990 there have been a few transplants, as well as a few years of healthy reproduction. As such, the present statewide estimate is likely around 31,500 (30,000 Merriam's, 1,300 Rio Grande, and 150-200 Gould's). Since numbers are subject to fluctuation dictated by annual weather cycles, this number may tend to vary between 27,000 and 36,000 (Kamees 2002).

Between 1994 and 1997, hunter participation dropped from an estimated 11,146 to 5,440. Turkey populations undoubtedly experienced declines due to the drought conditions over the past few years. Populations are expected to grow and expand as birds occupy habitats naturally and via transplants.

In New Mexico, the wild turkey is listed as "S5" (i.e., common, widespread, and abundant in the nation or state/province) (NatureServe 2010). Breeding bird surveys conducted between 1966 and 2007 indicate almost a 10 percent increase in wild turkey on an annual basis (Sauer et al. 2008).



Map 3. Distribution of Wild Turkey in North America (NatureServe Explorer 2010)

Carson National Forest

Populations have expanded on the Carson National Forest since the inception of the Forest Plan in 1986. For example, on the Jicarilla Ranger District, the Forest Service and NM Department of Game and Fish have cooperated in transplanting over 60 birds since 1988. The two agencies, as well as the Bureau of Land Management, conduct yearly gobbler surveys to track population trends. These surveys do not provide population numbers, but can show upward or downward trends. Results of these surveys have shown a steady or slightly increasing population since 1996. The population is doing well enough that the NMDGF and the Forest Service agreed to a limited hunt beginning in 1998. In the winter of 1995, 64 mix sexed Merriam's turkeys were transplanted on the Tres Piedras Ranger District in unoccupied range. After a few years of observations, the transplants have successfully occupied that portion of the district.

With the increase of harvest (hunting) areas on the Forest since 1986, it is reasonable to assume a population increase on the Carson National Forest. In fact, Unit 52 was open to turkey hunting in 2005. Population trend can be determined based on increased areas where turkeys are found, increased hunting areas opened to the public, and by hunter success. Wild turkey populations, nation-wide, are estimated to have increased by 3.7 to 4.2 million from 1990 to 1995 and from 1989 to 1995 there is an estimated 46% expansion of occupied range (Tapley 2000a).

As with most gallinaceous birds, turkeys can experience dramatic population fluctuations between years. Annual mortality rates can average from 30% to 55%, with most mortality occurring the first year of life. Rates decline after this time and remain somewhat stable for older birds (Kamees 2002). Drought conditions can significantly influence yearly reproduction of mast crops from piñon-juniper and oaks (Liedlich et al. 1991).

Based on data from the NM Department of Game and Fish, the Patuxent Research Center, the condition and trend of the turkey's habitat on the Forest and individual observations made by Forest Service biologists, **wild turkey populations on the Carson National Forest are considered to be in a stable to upward trend.** This confirms what the Forest Plan predicts of wild turkey populations over the course of plan implementation – "…populations are expected to increase because of improved habitat condition" (USDA 1986c, p. 238).

REFERENCES

Boeker E.L.; Scott, V.E. 1969. Roost tree characteristics for Merriam's turkey. Journal of Wildlife Management Vol. 33 No. 1. January 1969

Colorado Division of Wildlife. 1993. Management guidelines for Merriam's wild turkeys. Division Report No. 18. Fort Collins, CO: Colorado Division of Wildlife in cooperation with USDA Forest Service: 23 p.

Hoover, Robert L.; Wills, Dale L., eds. 1987. Managing forests for wildlife. Denver, CO: Colorado Division of Wildlife in cooperation with USDA Forest Service: 459 p.

Kamees, L. 2002. Long-range plan for the management of wild turkeys in New Mexico 2001-2005. New Mexico Department of Game and Fish. Available: http://www.wildlife.state.nm.us/conservation/wildlife_management_plans/documents/turkeylongrangeplan.pdf (Accessed: March 22, 2006)

Kennamer, J.E.; Kennamer, M.C; Brenneman. 1992. History of the wild turkey in North America. National Wild Turkey Federation. NWTF Wildlife Bulletin No. 15.

Kennamer, Mary C. 1992. Merriam's turkey. National Wild Turkey Federation. NWTF Wildlife Bulletin No. 4.

Liedlich David W.; Lockwood; D.R., Schemnitz, S.D.; Sutcliffe, D.H. ; Haussamen, W.C. 1991 Merriam's wild turkey reproductive ecology in the Sacramento mountains, South-Central New Mexico. New Mexico Agricultural Experiment Station Res. Bulletin 757. 38 p.

NatureServe Explorer: An online encyclopedia of life [web application]. 2010. Version 7.1. Arlington, Virginia, USA: NatureServe. Available: http://www.natureserve.org/explorer. (Accessed: March 15, 2011).

New Mexico Department of Game and Fish. 1961-1974. Turkey surveys. Federal Aid Project. Santa Fe, NM.

New Mexico Department of Game and Fish. 2011. BISON-M (Biota Information System of New Mexico): Biological database for New Mexico. NMDGF in cooperation with USDI BLM, USDI FWS, USDI Bureau of Reclamation, US Army Corps of Engineers, USDA Forest Service and University of New Mexico. http://www.bison-m.org. (Accessed: March 23, 2011)

New Mexico Partners in Flight. 2007. New Mexico Bird Conservation Plan Version 2.1.C. Rustay and S. Norris, compliers. Albuquerque, NM. 41 pages..

Reynolds, Richard T.; Graham, Russell T.; Reiser, M. Hildegard; and others. 1992. Management recommendations for the northern goshawk in the southwestern United States. General Technical Report RM-217. Fort Collins, CO: US Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 90 p.

Sauer, J. R., J. E. Hines, J. E. Fallon, K. L. Pardieck, D. J. Ziolkowski, Jr., and W. A. Link. 2011. The North American Breeding Bird Survey, Results and Analysis 1966 - 2009. Version 3.23.2011 USGS Patuxent Wildlife Research Center, Laurel, MD. Available: http://www.mbr-pwrc.usgs.gov/bbs/bbs.html. (Accessed: June 2, 2011).

Shaw, H.G.; Mollohan, C. 1992. Merriam's turkey p. 6-17 *in* J.B. Dickson ed.; The wild turkey biology and management. A National Wild Turkey Federation and USDA Forest Service Book. Stackpole Books. 436 p. (Carson Forest Supervisor's Office, Forest Biologist)

Tapley, Jennifer; Abernethy, Robert K.; Kennamer, James Earl; 2000a. Wild turkey status and range 2000. National Wild Turkey Federation. NWTF Wildlife Bulletin No. 21.

Tapley, Jennifer; Abernethy, Robert K.; Kennamer, James Earl; 2000b. Wild turkey expansion and density 2000. National Wild Turkey Federation. NWTF Wildlife Bulletin No. 22.

Temple, L.; Weybright, D. 1995. Big game surveys: Valle Vidal Merriam's turkey studies. Final Report, 1 April 1989: NM W-093-R-36/Job 14/Segments 32-36. Santa Fe, NM: 28 p.

USDA Forest Service. 1980. Report on Merriam's turkey habitat – Jicarilla Ranger District. USDA Forest Service, Southwestern Region, Carson National Forest.

USDA Forest Service. 1989-1998. Wildlife sighting forms for turkey on the Jicarilla Ranger District. USDA Forest Service, Southwestern Region, Carson National Forest.

USDA Forest Service. 2002. Fire Effects Information System, [Online]. Available: http://www.fs.fed.us/database/feis/. Fort Collins, CO: US Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory.

USDA, Forest Service. 2003. Management indicator species for the Carson National Forest – July 2003. Unpublished. 147 p.

USDA Forest Service. 2004 Survey Summaries from Jicarilla Ranger District.

USDA Forest Service. 2006. Use of North American breeding bird surveys on region 3 national forest and grasslands with an annotated bibliography. Unpublished briefing paper by Ernest Taylor, Regional Biologist, Southwestern Region, Albuquerque, NM. 13 p.

USDA Forest Service. 2007. Management indicator species for the Carson National Forest – June 2007. Unpublished. 169 p.

USDI Fish & Wildlife Service. 2008. Birds of Conservation Concern 2008. Division of Migratory Bird Management, Arlington, Virginia. 87 p. [online version available at < http://www.fws.gov/migratorybirds/NewReportsPublications/SpecialTopics/BCC2008/BCC2008.pdf >]

Wakeling B.F.; Rosenstock S.S.; and Shaw, H.G. 1998. Forest stand characteristics of successful and unsuccessful Merriam's turkey nest sites in North-Central Arizona. The Southwestern Naturalist 43 (2): 242-248.

Werner, J; Loe S.; Karp, P.; 1978. A Literature review and survey of various biologist on turkey habitat requirements and management. A White Paper for the Coronado National Forest. July 1978. 13 pp.

Rocky Mountain Bighorn Sheep (*Ovis canadensis canadensis*)

INDICATOR SPECIES HABITAT

Rocky Mountain bighorn sheep inhabit the cliffs and crags or other extremely rocky areas in tundra and alpine areas from the summit peaks to around 200 meters below the tree line of the Sangre de Cristo Mountains. The species is an indicator for the presence of alpine, subalpine tundra and mountain meadow grassland (USDA 1986a, p.97). Rocky Mountain bighorn sheep may have been extirpated from New Mexico, where it was native to the northern most area of the state. Populations have been reintroduced using more stock from the central and northern Rockies, and viable herds exist in several areas of the state, including the east-side of the Carson National Forest (NMDGF 2011a).

Bighorn prefer precipitous terrain adjacent to suitable feeding sites of high mountain meadows with grasses, forbs and browse species. Bighorn habitat is found in areas where canopy cover is less than 25 to 30 percent and slopes are greater than 60 percent for escape terrain adjacent to grazing areas. Forage, water, and escape terrain are the most important components of bighorn sheep habitat (Van Dyke et al. 1983, NMDGF 2005A).

Generally, bighorn sheep have two distinct, separate summer and winter ranges. Most of the year is spent on the winter range, where the elevation is typically below 10,826 feet (3,300 m). The aspect is usually south or southwest. Rams often venture onto the more open slopes, although rugged terrain is always nearby. During severe weather, if snow becomes unusually deep or crusty, bighorn sheep move to slightly higher elevations where wind and sunshine have cleared the more exposed slopes and ridges (NMDGF 2005A).

The spring range is generally characterized by the same parameters as the winter range; however, bighorn sheep will begin to respond to local green-ups along streambanks and valleys. Bighorn sheep heavily use areas around saltlicks in the spring. Preferred lambing range is in the most precipitous, inaccessible cliffs near forage, and generally has a dry, southern exposure.

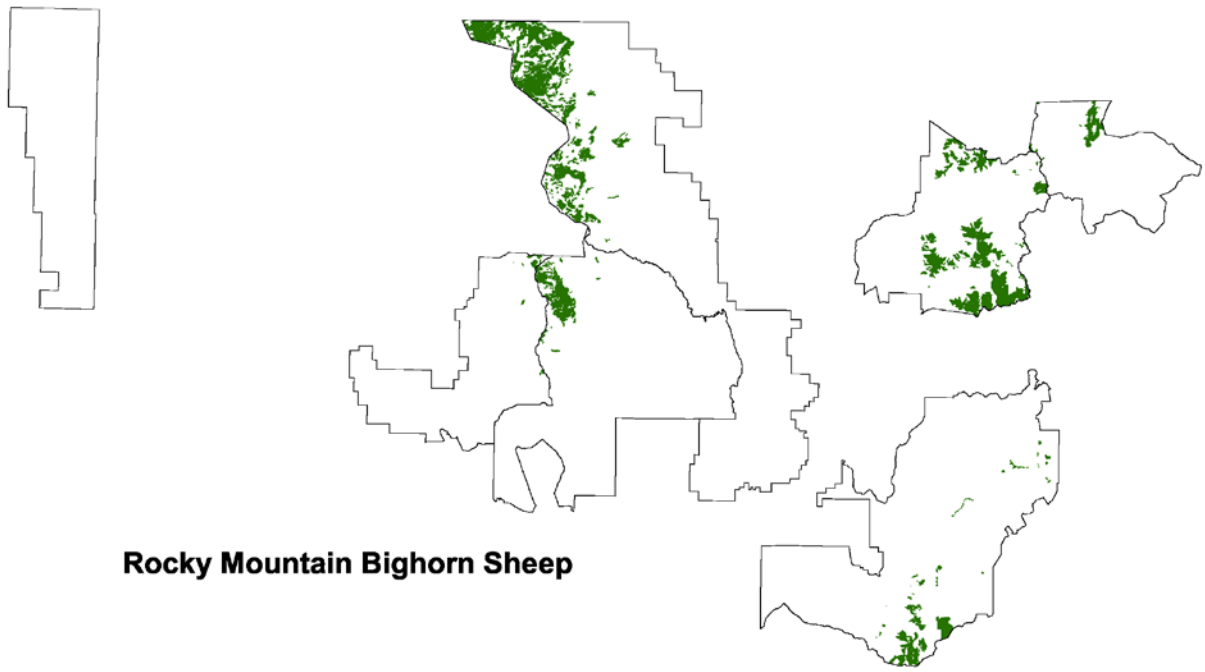
In the summer, bighorn sheep are mostly found grazing on high elevation grassland meadows and plateaus above timber. In early summer, south and southwestern exposures are most frequently utilized. By late summer the more northerly exposures are preferred. Snow accumulation seems to be the principal factor triggering bighorn sheep to move from summer to winter ranges (Van Dyke et al. 1983).

Bighorn sheep obtain water from dew, streams, lakes, springs, ponds, catchment tanks, troughs, guzzlers, and developed seeps or springs (Van Dyke et al. 1983). Alkaline water is not suitable. Bighorn sheep spend most of their time within 1 mile (1.6 km) of water but have been located as far as 2 miles (3.2 km) from water. Water sources more than 0.3 mile (0.5 km) from escape terrain or surrounded by tall dense vegetation are avoided by bighorn.

Escape terrain is an important habitat requirement for bighorn sheep. Cliffs, rock rims, rock outcroppings, and bluffs with sparse cover of trees or shrubs typify escape habitat, which provides both thermal and hiding cover. While bighorn are not always found in precipitous mountain areas, ewes and lambs rely on these places for escape cover, especially during the lambing period (Van Dyke et al. 1983, NMDGF 2005A). Visibility is another important habitat component. It allows for predator detection, visual communication, and efficient foraging (NMDGF 2005A). Bighorn sheep tend to forage in open areas with low vegetation such as grasslands, shrublands, or mixes of these. They avoid foraging on mild slopes with shrub or

canopy cover in excess of 25 percent and shrubs 2 feet (60 cm) or higher. On steep slopes they have been noted to travel through or bed in dense brush (Van Dyke et al. 1983).

Bighorn sheep primarily graze grasses and forbs, but eat other vegetation depending on availability. They prefer green forage and move up- or down-slope or to different aspects for more palatable forage. Forage areas that provide a variety of aspects are preferable because they offer green forage for longer periods (Van Dyke et al. 1983). Bighorn sheep eat sedges and a variety of grasses including bluegrasses (*Poa* spp.), wheatgrasses, bromes, and fescues. Browse species include sagebrush, willow (Salix spp.), rabbitbrush, curlleaf mountain-mahogany (*Cercocarpus ledifolius*), winterfat (*Kraschnennikovia lanata*), bitterbrush, and green ephedra (*Ephedra* spp.). Forbs include phlox (*Phlox* spp.), cinquefoil (*Potentilla* spp.), twinflower (*Linnaea borealis*), and clover (*Trifolium* spp.) (NMDGF 2011a). On the Carson National Forest, Rocky Mountain bighorn sheep are regularly observed along the highest (11,000-13,000 feet) ridges in the Pecos and Wheeler Peak wilderness areas (USDA 1987). Although Map 1 displays potential habitat on the west-side of the forest, however Rocky Mountain bighorn sheep are currently limited to the east-side of the Carson National Forest.



Map 1. Rocky Mountain Bighorn Potential Habitat Distribution on the Carson National Forest (USDA 1987)

Management Activities or Natural Events That May Affect Habitat

Negative: Recreation use, domestic sheep grazing, road use, fences, poor range conditions, excessive fire suppression, wild fire, severe winters, diseases specific to sheep, illegal harvest and predation (Dunn 1993).

Positive: Fire use (prescribed natural fire), possibly wildfire, and good grazing practices.

Plans, Regulations and Guidelines Supporting, Maintaining or Improving Habitat

- *Carson National Forest Land and Resource Management Plan, Management Area 9 (High Elevation Grassland)*. "Provide quality habitat for Rocky Mountain bighorn sheep" (USDA 1986c).
- *Long Range Plan for the Management of Rock Mountain Bighorn Sheep in New Mexico* (1996)
- *Wilderness Act* (1964) - Potential habitat for the bighorn is almost entirely located within the Pecos, Wheeler Peak and Latir Peak wilderness areas and the Columbine-Hondo Wilderness Study Area, and to a large extent security of bighorn habitat falls within the protections provided by the Wilderness Act.

HABITAT CONDITION AND TREND ON THE CARSON NATIONAL FOREST

In New Mexico, suitable range is relatively limited. It is believed bighorn sheep once occupied alpine ranges in most of New Mexico, implying the Pecos, Latir Peak, Wheeler Peak and Gold Hill areas of the Carson National Forest are historic ranges. Despite what is depicted in Map 1 (high elevation grasslands), the west-side of the Carson lacks the high elevation, rugged habitat of cliffs, crags, and rocky areas required to support a viable population of bighorn sheep.

The Forest Plan EIS identifies 20,430 acres of occupied bighorn sheep habitat on the Carson National Forest (USDA 1986a, p. 97). Based on Terrestrial Ecosystem Survey data, Map 1 displays only the alpine tundra portion (~ 10,100 acres) of bighorn habitat (USDA 1987). The Forest Plan EIS includes other adjacent alpine habitats; therefore the acres in Map 1 cannot be used in a habitat trend analysis. The core portions of bighorn habitat on the east-side can be found using Map 1. The removal of domestic sheep from the Latir Peak range is one management activity that has significantly increased habitat quality over the period of the Forest Plan. It is not certain if the acres originally identified in the Forest Plan EIS included this area.

Historically, for all existing bighorn sheep herds on the forest, reproduction has been high and mortality of young has not been significant. The Pecos, Wheeler Peak, and Latir herds quickly reached the carrying capacity of their range. The Columbine/Hondo Wilderness Study Area herd also grew from animals released in Wheeler Peak Wilderness (NMDGF 2003b). There are natural limits to growth, however, and as herd size goes over the carrying capacity of the habitat, it becomes more vulnerable to large-scale die-offs and lower birth weights.

Since bighorn are highly susceptible to the diseases carried by domestic sheep, the viability of the species is dependent on whether or not domestic sheep are present within their occupied habitat. In the Pecos and Wheeler Peak areas and recently in the Latir Peak region, domestic livestock have been converted from sheep to cattle in order to prevent any *Pasturella* bacteria infection of bighorn sheep. The cows on the allotment at the north end of the Pecos Wilderness rarely if ever access bighorn sheep habitat. This type of interaction occurs only periodically during the winter months when the livestock are off the allotment and conditions are severe enough to push bighorn down onto private land, below their normal or preferred habitat.

Suitable feeding sites of high mountain meadows with grasses, forbs and browse species provide for optimal populations density. A variety of impacts can adversely affect bighorn including recreation use, roads, fences, poor range conditions, fire suppression, diseases, illegal harvest and predation (Dunn 1993). A lack of natural salt deposits required for their diet commonly found bighorn sheep "begging for food" from wilderness recreation users. The NM Department of Game and Fish considered this type of human interaction with bighorn sheep as

unhealthy to the species. Cooperative salting in remote locations by the NMDGF and Forest Service and the Sikes Act Program has been implemented to address this issue.

Prescribed fire or natural fire use can be useful tools in managing bighorn sheep habitat (Peek et al. 1985). Prescribed burning has been widely used to increase the quantity and nutritional quality of bighorn sheep forage throughout North America (Easterly et al. 1991). Since both positive and negative effects can occur from burning bighorn sheep range, a well-thought-out plan must be developed before fire is considered for use on their range. Plans must take into account (Peek 1985):

- Condition of plants.
- Plant response to burning.
- Adjacent conifers (the possibility of creating more open range exists if conifer stands or tall shrub fields occur next to currently used ranges).
- Limiting factors. Factors that may limit bighorn sheep populations should be identified, and an evaluation made as to how burning will effect these limiting factors.
- Lungworm infections. Lungworm can possibly be altered by reducing bighorn sheep concentrations; however, if burns are small and concentrate bighorn sheep, results could be negative. If burning disperses populations, the effects could be positive.
- Competition from other ungulates attracted to burned areas.

Habitat conditions in the Pecos Wilderness Area are fair and stable, while the Wheeler Peak Wilderness Area, Latir Peak Wilderness Area, and Columbine-Hondo Wilderness Study Area are generally good and stable. There are a few locations where utilization is heavy, but these are isolated. The limiting factor for the bighorn is severe winter conditions when quality and quantity of forage can fluctuate significantly. Recent Forest Service management trends place more emphasis on thinning conifer encroachment and prescribed burning in transitory range, thus improving the quality of bighorn sheep habitat. **The habitat trend for Rocky Mountain bighorn sheep on the Carson National Forest is considered to be stable.**

POPULATION TREND

Rocky Mountain bighorn sheep are relatively widespread in western North America from central British Columbia and Alberta south to Colorado, although populations are smaller than in the past. In some areas, the species has been threatened by habitat changes resulting from fire suppression and human encroachment, as well as, by competition with feral and domestic livestock (NatureServe 2006).

Bighorn sheep are very susceptible to diseases. Incidence of lungworm infestation approaches 100 percent in some herds, although the level of individual infection varies depending upon sheep and domestic livestock densities, range conditions, climate, season, and age. A significant correlation exists between the intensity of the lungworm infestation and the amount of precipitation in the spring of the previous year.

The future of bighorn sheep depends on the preservation and improvement of critical native ranges. Bighorn sheep are poor competitors with other wild and domestic ungulates, and their range is diminishing. The effect of domestic livestock grazing on bighorn sheep is controversial and depends on the proximity and population size of competing species. Domestic livestock have been reported to have little deleterious effect if they do not graze on critical bighorn sheep winter ranges. Nevertheless, extensive competition by livestock persists and is one of the

reasons for the decline in density of bighorn sheep populations. Elk and mule deer can also be serious competitors with bighorn sheep on marginal habitat (Peek 1985).

The effects of human disturbance on bighorn sheep varies. Rocky Mountain bighorn sheep in New Mexico occur in areas with substantial human presence including hikers, skiers, dogs, off-road vehicles, trains, military and civilian aircraft and researchers and managers (NMDGF 2005A). Human activities responsible for declines in sheep use of an area include hiking and backpacking, snow skiing, fishing, motor biking, four-wheel-drive vehicle use, construction and use of roads, urban development, and recreational development. When bighorn sheep are pushed from prime to marginal habitat, mortality usually increases and productivity decreases. Some herds have adapted to human activity (Van Dyke et al. 1983).

Regional

The NatureServe database (www.natureserve.org/explorer) documents that throughout its range, the conservation status of Rocky Mountain bighorn sheep is ranked globally as “G4” and “T4” for populations. In other words, they are apparently secure (NatureServe 2011). Reasons given for the status ranking include the species being relatively widespread in western North America, although populations are smaller than in the past. In some areas bighorn are threatened by habitat changes resulting from fire suppression and human encroachment; also by competition with feral and domestic livestock.

New Mexico

Rocky Mountain bighorn were never prevalent in New Mexico, historically occurring in only four to six populations. In 2000, six populations with an estimated combined 580 to 720 animals were found in the state (NMDGF 2011b). In the 2010 alpine survey, eight populations comprised of an estimated 682 to 815 animals were found in the state (NMDGF 2011b). Bighorn sheep are usually characterized by low reproduction rates, long life spans, and populations that remain stable at near carrying capacity (NMDGF 1996).

Table 1. Population Trend for Individual Rocky Mountain Bighorn Sheep Herds In New Mexico, 2000-2010 (NMDGF, 2011b)

Herd	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Pecos	315-385	315-385	315-385	315-385	315-385	315-385	315-385	292-358	200-220	100-150	80-100
Wheeler Peak	160-200	180-220	205-250	225-275	270-330	270-330	305-375	295-360	250-300	215-255	225-275
Latir	0	56	75-95	95-115	115-145	135-165	135-165	70-80	70-75	80-100	85-90
Turkey Creek	35-45	30-40	40-50	40-50	40-50	40-50	75-85	65-75	65-75	50-70	50-70

Herd	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
San Francisco River	45-55	60-70	70-80	80-90	95-115	105-130	70-80	60-70	75-85	75-85	50-60
Manzanos	25-35	25-35	18-25	15-25	15-25	15-25	15-25	15-30	20-30	20-30	20-30
Dry Cimarron	0	0	0	0	0	0	0	35-40	55-60	70-80	60-70
Rio Grande Gorge	0	0	0	0	0	0	23	50-60	49-68	85-90	112-120
TOTAL	580 - 720	666-806	723-885	770-940	850-1050	880-1085	938-1138	882-1073	784-913	695-860	682-815

Dunn (1993) has observed that populations with more than 100 animals normally have the best chance for long-term persistence. In 2000, the only two herds exceeding 100 animals were the Pecos and Wheeler Peak herds. In the mid-2000's estimates for four locations exceeded the threshold: Pecos, Wheeler Peak, Latir, and San Francisco River. Currently, there are two locations with estimates exceeding 100 animals: Wheeler Peak and Rio Grande Gorge. Another five locations are approaching the 100 animal threshold (with high-end estimates ranging from 60 to 100 animals): Pecos, Latir, Turkey Creek, San Francisco River, and Dry Cimmarron.

Most mortality occurs during winter when weather is severe and forage quality and availability are low. Herds experiencing a population decline in the latter half of the 2000's may have suffered from the severe winter conditions experienced in northern New Mexico for several years during this period (R. Walker, pers. comm. 2011). A long-range (1996 - 2002) plan for management of bighorn in New Mexico was published in 1996 (NMDGF 1996) and in 2005 a new long-range plan (2005-2014) was published and is available at the New Mexico Department of Game and Fish website (NMDGF 2005A).

Carson National Forest

Native bighorn sheep populations were extirpated around the turn of the century, likely due to unregulated hunting and disease transmission from domestic sheep. Reintroduction of bighorn began in 1932, but was not successful. In the 1960's, another attempt was made and Bighorn were successfully reintroduced into the Pecos Wilderness. An extensive habitat distribution and food habits evaluation was conducted from 1976 to 1978.

Pecos Wilderness

The continuous alpine habitat in the Pecos Wilderness is estimated at 27 square miles. The estimated carrying capacity based on winter range was thought to be 175 to 330 animals (NMDGF 2005A). However, the number of animals in the Pecos quickly grew to exceed this anticipated carrying capacity. Between 1989 and 2006, population estimates fluctuated between

300 and 400 with high winter mortality in the lamb and yearling cohorts during severe winters. This strongly suggests a density dependent carrying capacity tightly linked to winter severity, with a maximum carrying capacity of around 400 animals (Rominger 2001).

The Forest Plan EIS considered the bighorn herd in the Pecos Wilderness to be unstable and a downward trend was expected (USDA 1986a, p. 98). So recent estimates of a declining population in the Pecos herd were not unexpected. NMDGF cites several potential factors for the recent indications of decline: 1) Changes to survey methodology; 2) Potential over-estimates of earlier animal counts; 3) Several severe winters in recent years; and 4) Reductions in the number of salt locations on the Pecos (R. Walker, pers. comm. 2011).

Wheeler Peak Wilderness

In 1993, the NM Department of Game and Fish (NMDGF) determined that the Pecos population, which had theretofore consistently increased, would be a primary source of sheep for transplant to other areas thought to have suitable habitats. Thirty-three animals from the Pecos herd were transplanted to the Wheeler Peak Wilderness and adjacent Columbine-Hondo Wilderness Study Area (NMDGF 1993). The Wheeler Peak population subsequently grew to an estimated 305-375 animals in 2006. Recent estimates suggest that the herd was well over carrying capacity. NMDGF estimates the carrying capacity at somewhere between 180 and 243 animals (NMDGF 2005A). NMDGF has been capturing bighorn sheep from the Wheeler Peak area since 2003 to reduce population numbers and to bring the herds within carrying capacity. So recent declines in the estimated population of this herd were also expected. The estimated herd size for 2010 was 225 to 275 animals.

Latir Peak Wilderness

Expecting the Latir Peak Wilderness to be equally suitable as the Wheeler Peak area, the NM Department of Game and Fish relocated 56 bighorn sheep from the Pecos Wilderness to the Latir Peak Wilderness in August 2001. Monitoring of the herd later in September 2001 indicated healthy individuals and an especially vigorous lamb crop. The Latir Peak population is estimated to have a carrying capacity of between 56 and 76 animals (NMDGF 2005A).

The Latir Peak herd quickly grew to an estimated size of 135 to 165 animals in 2005. In 2006, the New Mexico Department of Game and Fish removed bighorn sheep from the Latir herd to reduce the number of sheep in the area. The New Mexico Game Commission has permitted the sale of two public hunting tags and the option for auction/raffle hunter to hunt in this area. The herd size has subsequently declined to an estimated 85 to 90 animals in 2010, a population size that is much more consistent with the estimated carrying capacity (NMDGF 2010a).

The success of transplanted populations in the Wheeler Peak and Latir Peak areas demonstrates the success of Rocky Mountain bighorn sheep and species viability in New Mexico. Herd sizes on Carson alpine wilderness areas have remained at or above estimated carrying capacities, despite removals by NMDGF, Bighorn hunts, and several severe winters. Bighorn sheep populations on the Carson may be approaching overall carrying capacity imposed by the limited range available on the Carson. However, the historical population growth confirms what the Forest Plan predicted over the course of plan implementation – "…populations are expected to increase because of improved habitat condition" (USDA 1986c, p. 238). **The population of Rocky Mountain Bighorn Sheep on the Carson National Forest is considered stable.**

REFERENCES

Dunn, William C. 1993. Evaluation of Rocky Mountain bighorn sheep habitat in New Mexico. Final report submitted to the NM Department of Game and Fish, Federal Aid in Wildlife Restoration Project W-127-R-9/Job 9. Santa Fe, NM. 60 p.

Easterly, Thomas G.; Jenkins, Kurt J. 1991. Forage production and use on bighorn sheep winter range following spring burning in grassland and ponderosa pine habitats. Prairie Naturalist. 23(4): 193-200.

Findley, J.A.; Harris A.H.; Wilson, D.E.; Jones, C. 1975. Mammals of New Mexico. Albuquerque, NM: Univ. of New Mexico Press: xxii + 360 p.

Hass, Christine C. 1995. Population estimates of bighorn sheep in the Pecos Wilderness, New Mexico. Report presented to New Mexico of Game and Fish. Flagstaff, AZ. 5 p.

NatureServe. 2011. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe. Arlington, Virginia. Available: http://www.natureserve.org/explorer. (Accessed: August 21, 2011).

New Mexico Department of Game and Fish. 1993. Rocky Mountain bighorn sheep transplant from the Pecos Wilderness to the Wheeler Peak Wilderness Area. Environmental assessment and decision notice. Santa Fe, NM: Department of Game and Fish and US Department of Agriculture, Forest Service. 41 p.

New Mexico Department of Game and Fish. 1996. Long range plan for the management of Rock Mountain bighorn sheep in New Mexico. Federal aid wildlife restoration grant W-93-R38, Project 1, Job 7.5. Santa Fe, NM: NM Department of Game and Fish.

New Mexico Department of Game and Fish. 2001a. Putting the “wild” in the wilderness: trapped bighorn repopulate vacant range. New Mexico Wildlife. 46(3) Autumn 2001.

New Mexico Department of Game and Fish. 2001b. Rocky Mountain bighorns flourish. Share with Wildlife - Update. Winter 2001-2002.

New Mexico Department of Game and Fish. 2003a. Goldstein (e-mail communication).

New Mexico Department of Game and Fish. 2003b. Goldstein (e-mail communication).

New Mexico Department of Game and Fish. 2005a. Long range plan for the management of Rocky Mountain bighorn sheep in New Mexico. Santa Fe, NM: New Mexico Wildlife Management Division, New Mexico Department of Game and Fish. November 9, 2005.

New Mexico Department of Game and Fish. 2005b. Goldstein (e-mail communication).

New Mexico Department of Game and Fish. 2006a. Goldstein (e-mail communication).

New Mexico Department of Game and Fish. 2006b. BISON-M (Biota Information System of New Mexico): Biological database for New Mexico. NMDGF in cooperation with USDI BLM, USDI FWS, USDI Bureau of Reclamation, US Army Corps of Engineers, USDA Forest Service and University of New Mexico. http://fwie.fw.vt.edu/states/nmex_main/species/050215.htm. (Accessed: January 12, 2007).

New Mexico Department of Game and Fish. 2010a. Goldstein (e-mail communication).

New Mexico Department of Game and Fish. 2011a. BISON-M (Biota Information System of New Mexico): Biological database for New Mexico. NMDGF in cooperation with USDI BLM, USDI FWS, USDI Bureau of Reclamation, US Army Corps of Engineers, USDA Forest Service and University of New Mexico. http://www.bison-m.org. (Accessed: March 23, 2011)

New Mexico Department of Game and Fish. 2011b. New Mexico Wildlife [Online]. Available: http://www.wildlife.state.nm.us/. (Accessed: August 21, 2011)

Peek, James. 1985. Bighorn sheep responses to fire. The Habitat Express. No. 85-4. Ogden, UT: US Department of Agriculture, Forest Service, Intermountain Region. 3 p.

Smith, Dwight R.; Johnson, Bruce K. 1979. Bighorn sheep distribution, habitat evaluation, and food habits, Pecos Wilderness, New Mexico. Final Report submitted to the Santa Fe and Carson National Forests. Fort Collins, CO: Department of Fishery and Wildlife Biology, Colorado State University. 185 p.

USDA Forest Service. 2002. Fire Effects Information System, [Online]. Available: http://www.fs.fed.us/database/feis/. Fort Collins, CO: US Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory.

Van Dyke, Walter A.; Sands, Alan; Yoakum, Jim; [and others]. 1983. Wildlife habitats in managed rangelands--the Great Basin of southeastern Oregon: bighorn sheep. General Technical Report. PNW-159. Portland, OR: US Department of Agriculture, Forest Service, Pacific Northwest and Range Experiment Station. 37 p.

White-tailed Ptarmigan (*Lagopus leucurcus*)

INDICATOR SPECIES HABITAT

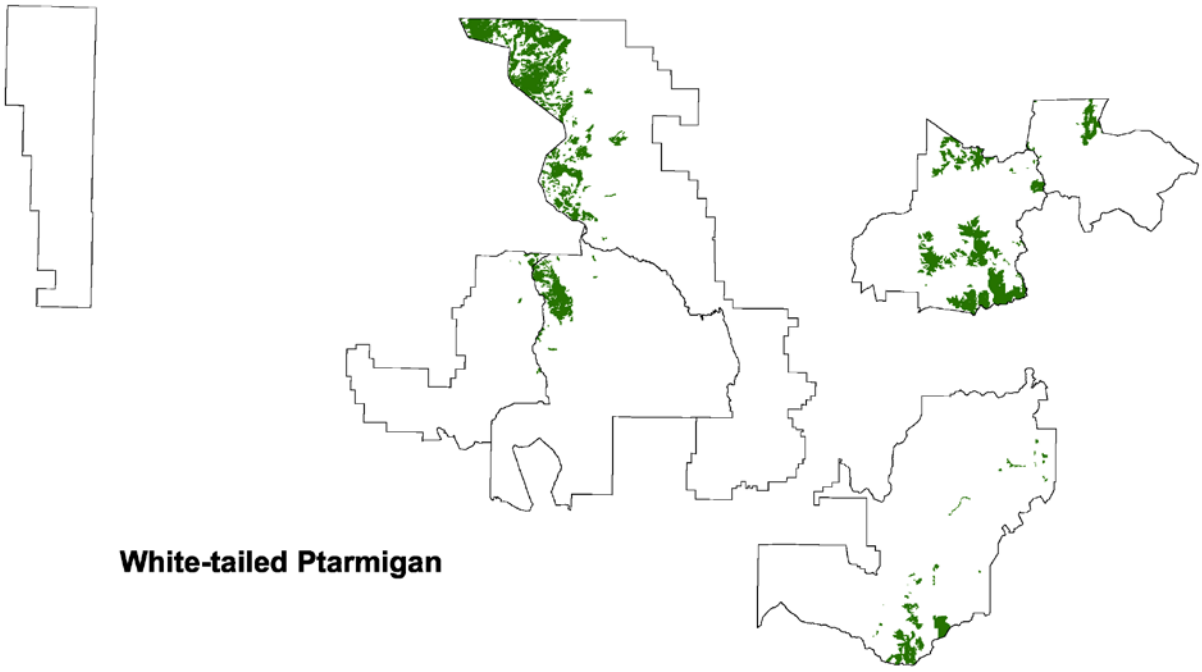
The white-tailed ptarmigan is an indicator species for the presence of alpine tundra and subalpine deciduous shrub (USDA 1986a, p.97). The white-tailed ptarmigan is the only ptarmigan confined to North America. Little is known about this avian species in New Mexico, for it lives on the windswept tundra, above 11,000 feet (3350 meters). Hens have been observed wintering as low as 8,500 feet (2590 meters). The presence of high elevation shrubby willows (*Salix* spp.) is likely the most important factor for successful overwintering of the species (Hoffman 2006). Buds and twigs of various species of *Salix* provide the bulk of the food eaten by white-tailed ptarmigan. The shrubs should reach a minimum height of 0.5 meters. In areas where *Salix* is not readily available, alder catkins (*Alnus* spp.) become the dominant dietary component, along with some needles of spruces, pines, and firs.

Habitat distribution should include soil map units 340 and 341 of the Terrestrial Ecosystem Survey for the Carson National Forest (USDA 1987). Key habitats include krummholz (stunted forest characteristic of timberline) thickets and boggy meadows. Important willow species should include gray-leaf willow (*S. glauca*) and plane-leaf willow (*S. planifolia*). Ptarmigan can easily be overlooked in the dwarf willow communities of skyland willow (*S. petrophila*), arctic willow (*S. artica*), and snow willow (*S. nivalis*) that create tiny, low mats on wet, rocky habitats.

Most plant communities in the alpine zone are used by ptarmigan at some time during the year, suggesting the species has a wide habitat tolerance in this zone. However, certain habitat features must be present to ensure continued use. The two most important features of all vegetation types are the presence of willow and rocky areas. Willow is the key factor affecting ptarmigan distribution from late fall through early summer. During this time, this shrub species is the primary source of food for the ptarmigan. Rocky areas near late-lying snowfields or other moist sites become important from mid-summer to early fall. Rocks provide protection from the weather and hiding cover from avian predators (Hoffman 2006).

Nesting habitat varies significantly. Some birds will use the cover of various shrubs and trees, while others will nest in the alpine meadows. After completing breeding activities in early July, most males and unsuccessful females move upslope from breeding areas to high, rocky, and frequently exposed ridges. Feeding often occurs along the edges of melting snow packs. *Trifolium* and *Carex* are important forage during the summer months.

Winter ranges are at or near timberline and preferably consist of a willow-sedge (*Salix* spp. and *Carex* spp.) marsh, hairgrass (*Deschampsia*) meadow, sedge-grass (*Carex-Poa*) wet meadow and krummholz mosaic dominated by willow and dwarf Engelmann spruce (Braun et al. 1976). Summer ranges are areas above timberline that ptarmigan move to in early July. Typically they are windswept ridges, with rocky 50 percent ground cover, with short grass-sedge meadows adjacent to late-lying snowfields (Braun 1971). Both genders show a high fidelity to wintering areas similar to their attachment to breeding sites. Studies indicate about 60 percent of the birds return to the same wintering area (Hoffman 2006), with adults exhibiting a greater affinity for wintering areas than subadults. If suitable winter habitat occurs closer to the subadults' territory than where they wintered the previous year, they will use the closest habitat and not return to the area used the previous winter (Hoffman 2006).



Map 1. White-tailed Ptarmigan Potential Habitat Distribution on the Carson National Forest (USDA 1987)

Management Activities or Natural Events That May Affect Habitat

Negative: Loss of willow component, usually associated with domestic sheep grazing; use of tundra habitats by livestock (particularly sheep), elk, and wilderness users (humans).

Positive: Fire use (prescribed natural fire); good grazing practices.

Plans, Regulations and Guidelines Supporting, Maintaining or Improving Habitat

- *Carson National Forest Land and Resource Management Plan – Management Area 9 (High Elevation Grassland)* (USDA 1986c) says to "provide quality habitat for ptarmigan" and "willow is in the ptarmigan range and has a height of at least 0.5 meter."
- *Wilderness Act* (1964) – Potential habitat for the ptarmigan is located entirely within the Pecos, Wheeler Peak and Latir Peak wilderness areas and the Columbine-Hondo Wilderness Study Area, and to some extent security of ptarmigan habitat falls within the protections provided by the Wilderness Act.

HABITAT CONDITION AND TREND ON THE CARSON NATIONAL FOREST

This species is associated with the alpine tundra and subalpine deciduous shrub. The Carson Forest Plan EIS identifies 6,400 acres of habitat (USDA 1986a, p. 97). It also states habitats are marginal compared to areas further north in Colorado, and localized extinctions of populations could occur when densities are low. Map 1 depicts habitat on the west-side of the forest, however Braun (1971 and 1979) notes the area near Chama could be used as wintering habitat, but does not provide breeding or summer habitat.

No management actions have changed since the time of the Forest Plan that would cause a change in the number of acres of available habitat on the Carson National Forest. The Terrestrial Ecosystem Survey data layer identifies 10,106 acres of alpine tundra on the Forest (USDA 1987). This does not mean there is any change in the trend of available habitat, but is a result of a variation in habitat mapping. Incidental observations show portions of these habitats are still occupied. The most recent photo verification is in the Pecos Wilderness in 2002 (Gardiner 2002).

Figure 1 displays the approximate distribution of seasonal ranges of white-tailed ptarmigan in Colorado in relation to elevation, topographic position, and major alpine vegetation types (Hoffman 2006). The actual distribution of seasonal ranges will vary depending on the aspect and the elevations may be slightly different for New Mexico.

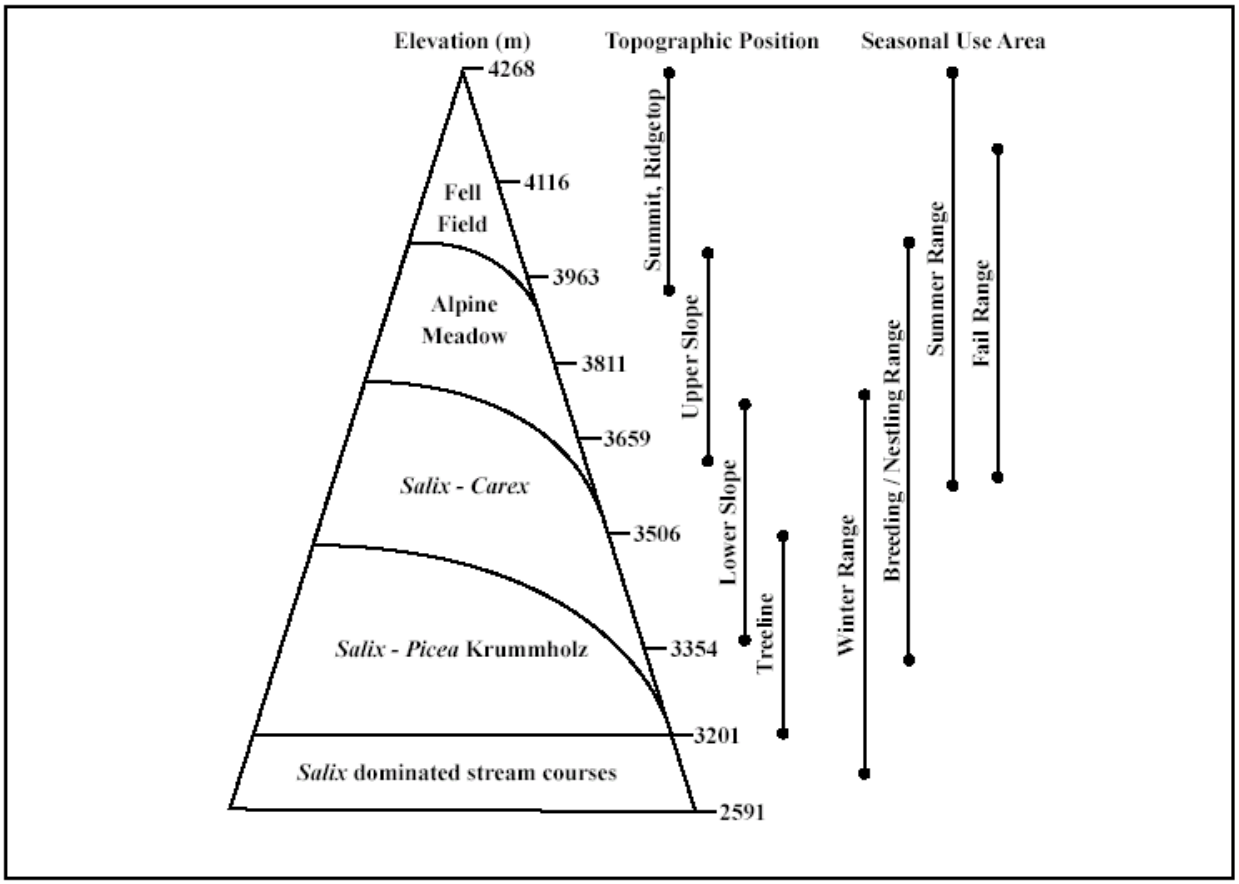


Figure 1. Distribution of Seasonal Ranges (Hoffman 2006)

In New Mexico, white-tailed ptarmigan populations exist year-round on the peaks of the Sangre de Cristo Mountains from the vicinity of Santa Fe northward to the Colorado border. This region includes the eastside of the Carson National Forest. They have been found in the Chama area, but only during the winter. The decline in ptarmigan numbers in New Mexico is due to many reasons. The historic use of tundra habitats by livestock, particularly sheep, and the increase use of wilderness areas by humans have had negative impacts on the species and its habitat.

Photos from as early as the 1920's indicate the alpine meadows in what is now the Pecos Wilderness were severely overgrazed. This condition is most likely the reason for the rare

occurrence of the species today. Different behavioral patterns have been found to occur in areas of Colorado, which were intensively grazed by domestic livestock. When the upper ridges were heavily grazed there was no movement to these areas in the post-breeding season. Instead, there was lateral or horizontal movement to rocky areas or movement downhill into rocky and wet places within the krummholz. Fall habitats are primarily the last places where snow has melted. Phenology of these areas is delayed because they are the last to become snow free in late summer, and consequently they are the only remaining source of green plants in the late fall (Braun 1979).

Braun (1979) does not believe grazing has had a negative effect on ptarmigan populations in Colorado. He observed the movement pattern went from upslope in summer to lateral or downward to find adequate forage. From his studies, he is unable to determine the extent of livestock utilization or the duration of any severe utilization and how it compares to impacts of livestock grazing in the Pecos, Latir, or Wheeler Peak wilderness areas. It is also possible that rocky, wet areas in his study are protected from grazing and may be more extensive in Colorado than in New Mexico. In addition, certain species of willow may be more valuable and not have persisted during the years of intensive grazing. Future studies could determine if the willow species found in Colorado are still present or to what abundance in historic habitats in New Mexico.

Clait E. Braun (former white-tail ptarmigan researcher for the Colorado Division of Wildlife) surveyed habitat condition on the Carson National Forest in both 1969 and 1979 (Braun 1969; 1979). In Braun's habitat evaluations of New Mexico, he was accompanied by several Forest Service personnel (Braun 1979). The following is a summary of his 1979 report:

> Latir Peak area – Isolated, small (~3 square miles) alpine area is dominated by *Carex* spp.- *Trifolium dasyphyllum* (alpine clover), *Carex* spp. *T. nanum* (dwarf clover), and *Carex* spp. – *Geum rossi* (Ross's avens) communities at higher elevations (up to 12,000 feet). Lower elevations are dominated by *Potentilla* spp. and *Poa* (grasses) spp., with some *Deschampsia* (grass) and *Kobresia* (sedge) in suitable sites. The limited krummholz in this area is dominated by *Ribes* (currant) and *Potentilla*. Salix (willow) brushes are conspicuously absent, although prostrate or mat willows do occur in suitable sites. The suitable of Latir Peak-Latir Mesa-Venada Peak is that it is marginal and breeding and winter habitat is almost non-existent. This is especially true for the breeding period as exposed willow in the krummholz is lacking. Some taller willow exists in drainages away from the alpine and it is probable that ptarmigan could utilize this resource.
>
> Wheeler Peak area – Vegetation within this area is typically alpine being dominated by *Carex, Trifolium, Geum,* and *Kobresia,* with *Potentilla, Poa,* and *Deschampsia* being abundant in some sites. Prostrate *Salix* is common and bushes of *Salix* occur in some of the more poorly drained sites. Condition of the alpine vegetation is excellent. Wheeler Peak area has a lack of breeding areas and possibly winter use sites. Bush willows are not abundant, although some occur in La Cal Basin, near Horseshoe Lake and the basin below Wheeler Peak and Old Mike. This area does not contain large amounts of superlative breeding habitat.

> Jicarita Peak-Truchas Peaks-Pecos Baldy-Santa Fe Baldy-Lake Peak Area – This area represents the largest area of continuous alpine habitat (~10-12 air miles in length) in New Mexico, which includes both Carson and Santa Fe National Forests. This area contains the best ptarmigan habitat in New Mexico.
>
> The area from Jicarita Peak to Barbara Peak especially the east side from Serpent Lake to the head of Rincon Bonito and possibly east to Santiago Lake, appears excellent for ptarmigan breeding and winter use. Bush *Salix* is abundant along the east side of the Divide trail with obvious windblown areas suitable for breeding territories. The divide area itself is dominated by communities of *Carex-Geum, Geum-Carex,* and *Carex-Geum-Trifolium.* Some *Kobresia* is present, as is *Deschampsia*. Prostrated willows are common. Rock patterned ground, stripes, nets and polygons occur in profusion, frequently in close proximity to late lying snowfields and wet seeps. This area of about five miles in length by up to one mile in width appears markedly similar to some of Colorado's better ptarmigan areas.
>
> New Mexico habitat – Overall alpine habitats in New Mexico are marginal for white-tailed ptarmigan breeding and wintering. Maintenance of viable populations is possible near Chama (winter only), Costilla Peak, Wheeler Peak area and with introduction, the Barbara Peak-Jicarita Peak area. All other areas appear capable of supporting only transients or limited numbers in times of high populations in the best habitats.

During 2006, the Carson National Forest invited Clait Braun to the forest to provide training to district personnel on conducting ptarmigan surveys and assessing habitat conditions. During this training session, actual surveys were conducted in the Pecos Wilderness area (Braun 2006). Braun (2006) noted that in the Jicarita Peak area the area has not changed from that noted during his visit in 1979 as being good habitat for the ptarmigan. He noted the vegetation changes appeared to consist of continued recovery of the alpine turf communities and some excessive browsing of willow bushes, presumably by elk.

Also in 2006, Little Costilla Peak in the Valle Vidal area on the Questa Ranger District was field checked to determine its potential for breeding habitat. Surveys of potential ptarmigan habitat were conducted along the Little Costilla Peak ridge during the August 2006 (USDA 2006b). No quality habitat or evidence of ptarmigan was found. The Little Costilla Peak area, however, could be transient range for ptarmigan between breeding and wintering habitat (July–September).

Domestic sheep were removed from the Pecos Wilderness about 25 years ago. Today, cattle do not access the upper slopes; however they still graze the lower areas where *Salix* occurs. These *Salix* patches are in good condition and do not show signs of extensive use by livestock. The main competition for *Salix* on the upper slopes is from bighorn sheep, and to some extent elk. Although the ptarmigan and these species did naturally occur together, it is believed the *Salix* has never effectively recovered from 75 years of heavy use prior to domestic sheep removal from the wilderness. The habitat condition and trend on the Carson National Forest for the white-tailed ptarmigan is generally poor and varies between a stable and downward trend.

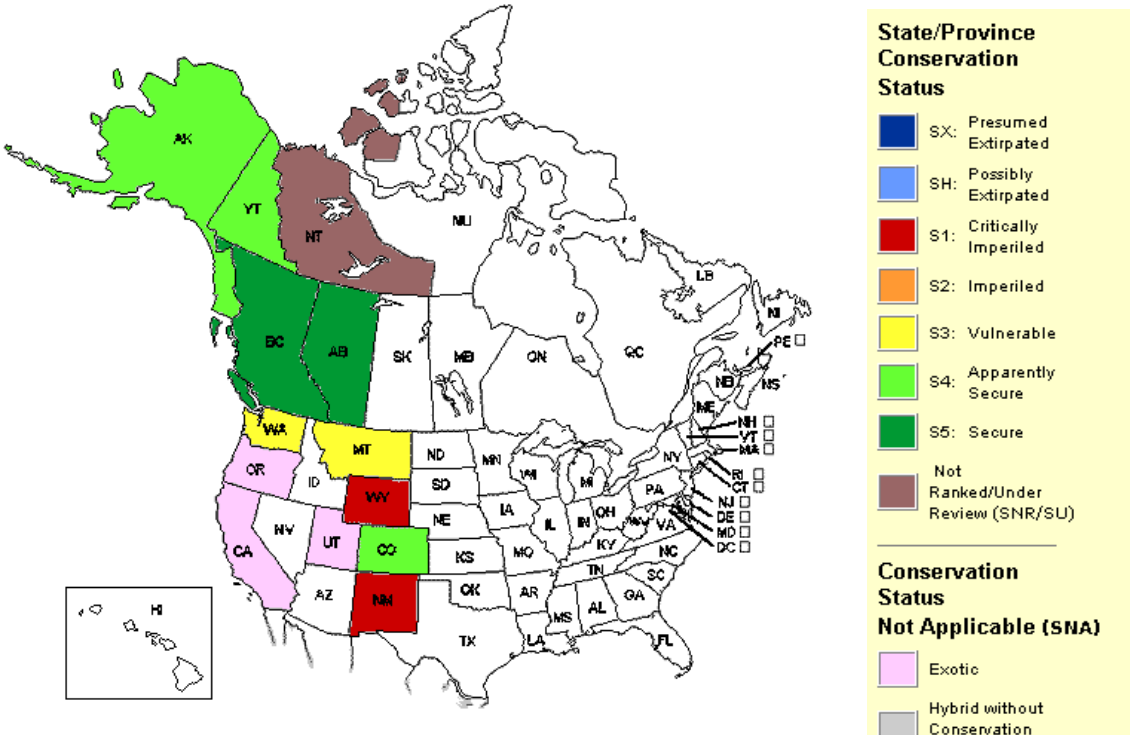
Currently, combined Rocky Mountain bighorn sheep and elk forage utilization along specific areas of the alpine zone may be affecting recovery of tall willow species needed for ptarmigan habitat. Current willow populations for winter survival can only be found in a few spots of TES units 340 and 341 and comprises only a "trace" of percent cover. Because livestock class has changed from domestic sheep to cattle in all allotments affecting alpine habitats on the Carson National Forest, current livestock grazing utilization levels have no effect on existing willow populations in areas where ptarmigan habitat occurs.

The increase of the elk population on the forest since the implementation of the Forest Plan could affect ptarmigan habitat conditions. Use of willow by elk in early winter and early spring may constrain ptarmigan breeding densities by reducing the amount of willow protruding above the snow (Hoffman 2006). Braun (2006) notes, while putting on a training session in the area south of Jicarita Peak, he observed excessive browsing of willow bushes, presumably by elk, as their sign was found in the area. Considering the positive adjustments in grazing management on the forest and little change in habitat conditions detected by Braun between 1979 and 2006, **the overall habitat trend for the white-tailed ptarmigan on the Carson National Forest is stable.**

POPULATION TREND

The white-tailed ptarmigan is a resident of central Alaska, northern Yukon, southwestern Mackenzie, south to Kenai Peninsula; Vancouver Island, Canada, Cascade Mountains in Washington, and in the Rocky Mountains from British Columbia and Alberta south to northern New Mexico; introduced and established outside its native range in high central Sierra Nevada in California; releases also have been made in the Wallowa Mountains in Oregon, Pike's Peak in Colorado and Uintah Mountains in Utah (Hoffman 2006). The ptarmigan is locally common over many parts of its range, but in New Mexico the species has become rare since the turn of the century. By the early 1900s, the white-tailed ptarmigan had become extremely rare throughout its New Mexico range and by the mid-1900s it was extirpated from the southern peaks and restricted to only a few peaks in the northernmost reaches of its former habitat. In Colorado the white-tailed ptarmigan is considered a fairly common game species and is regulated through hunting seasons. In New Mexico, however, the species is listed as endangered by the State and is protected.

The *NatureServe* database (www.natureserve.org/explorer) documents that throughout its range, the white-tailed ptarmigan is listed as “G5”, (i.e., globally secure and common, widespread and abundant) although it may be rare in parts of its range, particularly on the periphery (such as New Mexico). Reasons given for the G5 ranking are its large range and that it is common in many areas and there is no evidence of large-scale declines. It is not vulnerable in most of its range. Species with this rank typically occur in more than 100 localities, and there are more than 10,000 individuals. Within the United States, the white-tailed ptarmigan is listed as “N5” (i.e., secure and common, widespread, and abundant). In New Mexico, the species is listed as “S1” (i.e., critically imperiled). Ptarmigan are critically imperiled in New Mexico because of extreme rarity or other factor(s) such as very limited habitats, making it especially vulnerable to extirpation from the state. Typically this means only five or fewer occurrences or very few remaining individuals (<1,000) exist.



Map 2. Distribution of White-tailed Ptarmigan in North America (NatureServe Explorer 2010)

New Mexico and Carson National Forest

In 1979, Clait E. Braun conducted a literature search and habitat evaluations on white-tailed ptarmigan in New Mexico (1979). The following information is from his report: White-tailed ptarmigan were first collected in New Mexico sometime before 1866. The exact locations of these collections are unknown, but Bailey presumed the birds came from the Truchas Peaks, however Braun notes it is more likely they came from the Taos area. Other specimens were taken in the Wheeler Peak area and on Costilla Peak in 1904. Oldenettel (2007) notes white-tailed ptarmigan were found on Costilla Peak in 1926 (11 birds) by Ligon and in 1952 (7 birds) by Brewser.

Braun (1979) indicates there were only four known specimens of white-tailed ptarmigan in museums in 1970. All were from north of Taos. Braun noted he had supportable observations of the southern-most factual records, as far south as the Santa Fe Baldy area in 1974. He does not agree with Bailey, and can find no data to suggest ptarmigan were once common from Wheeler to the Colorado line. He also notes it is doubtful a viable population of ptarmigan ever existed in the Pecos Wilderness Area, since it is not likely the species would have been eliminated through over-grazing, over-hunting (there would be specimens), or a combination of the two factors.

Braun (1979) also noted the white-tailed ptarmigan occupy essentially the same area in New Mexico at present as they did historically. They are found from Costilla Peak south to Latir Peak and the Wheeler Peak area. Birds occasionally seen south of Wheeler Peak are undoubtedly transients as no established populations are known to exist in the Jicarita Peak-Lake Peak area. There are no data to suggest viable populations (transients in winter only) have ever occurred

south of Wheeler Peak. Birds periodically seen near Chama are winter migrants from the southern San Juan Mountains in Colorado.

The following is Braun (1979) assessment of population potential in the Latir, Wheeler Peak and Pecos wilderness areas.

> Latir: Due to the lack of breeding and winter habitat, ptarmigan could exist in the Latir Peak area from June-October. The lack of breeding and winter habitat will result in the periodic extinction of this population. It will continue to be periodically restocked with emigrants from Costilla Peak (<10 miles north) and Wheeler Peak (10-12 miles south).
>
> Wheeler Peak: This alpine area could support 15-20 pairs of ptarmigan. It is unlikely that the total population was more than 50 breeding pairs. This population level could not be sustained on a long term basis considering the white-tail ptarmigan life cycle appears to be cyclic. Due to the area not containing large amounts of superlative breeding habitat, breeding densities will be low with almost no potential for substantial increases.
>
> Pecos Wilderness (both Carson and Santa Fe National Forests): The area from Jicarita Peak to Barbara Peak; from Serpent Lake to the Rincon Bonito and east to Santiago Lake appears capable of supporting at least 10 and probably 15 breeding pairs per square mile.
>
> It is unlikely that a viable ptarmigan population could be maintained south of Barbara Peak. At best in some years a few birds might exist south of this area if a population was established between Jicarita and Barbara Peaks.

In 1981, a reintroduction[1] of the white-tailed ptarmigan was made in the Pecos Wilderness. The New Mexico Department of Game and Fish (NMDGF), along with the Colorado Division of Wildlife and the Forest Service, transplanted 43 birds into unoccupied habitat in the Truchas Peak area. Further sightings of adults and young show the reintroduction appears to have been successful. In September 1984, Santa Fe National Forest conducted surveys and located 24 ptarmigan. Based on the limited number of banded birds and the age class structure, the surveys indicated vigorous recruitment since 1981 release (USDA 1984).

[1] Some documents call this release an “introduction” and some a “reintroduction.” In Hoffman (2006) it is directly stated this is a “new population.”

Table 1. Sighting of Ptarmigan on the Carson and Santa Fe National Forests Since 1985

Year	Location	Number of birds	Source
1985	Truchas Peak Rincon Bonito Jicarita Peak	10 5 4	Oldenettel 2007
1986	Santa Fe Baldy Rincon Bonito	1 12	Oldenettel 2007 Natural Heritage 2006
1987	Pecos Baldy	5 (1 female and 4 young)	Natural Heritage 2006
1990	Santa Fe Baldy	4	Oldenettel 2007
1993	Barbara Peak	nest site (1)	NMDGF 2001 Oldenettel 2007
1996	Barbara Peak	4 subadults and pair w/3 young	Oldenettel 2007
1999	Pecos Baldy Wheeler Peak	1 6	Oldenettel 2007
2000	Kachina Peak Jicarita Peak Mt. Walter (near Wheeler	5 6 3	Oldenettel 2007
2002	Latir Peak Wheeler Peak Jicarita Peak Truchas Peak Jicarita Peak Santa Fe baldy	5 11 5 (pictures) 1 2 feather	Oldenettel 2007 Gardiner 2002
2004	Jicarita Peak Jicarita Peak Jicarita Peak	1 3 2	Oldenettel 2007
2005	Barbara Peak	pair with chick	Oldenettel 2007
2006	Jicarita Peak Jicarita Peak Rio Santa Barbara	3 adults 3 males and 1 female 2 males	Wolfe 2006 Braun 2006 Braun 2006

While conducting the Rocky Mountain bighorn sheep study to determine population estimates in 1995, fresh ptarmigan sign was reported on top of East Pecos Baldy. During the Braun (2006) field visit, he observed old winter droppings and or white feathers. It was Braun's professional view the area would only support a low breeding density of birds, due to the large amount of unsuitable areas (little snow cover, little rock cover, few if any willows, and little relief) within the Pecos Wilderness. His conclusion was the white-tailed ptarmigan are established in the Pecos Wilderness Area from at least Jicarita Peak on the north to at least the high point above the Middle Fork of the Rio Santa Barbara.

Table 2. Bird Densities in Different Areas of the U.S. (Braun et al. 1993)

Area	Birds Per Km^2	Birds Per Hectare	Birds Per Acre
Colorado: Mt. Evans	2.0 - 10.3	0.02 - 0.103	0.008 - 0.042
Colorado: Rocky Mountain National Park	4.5 - 13.5	0.045 - 0.135	0.018 - 0.055
Montana	6.7	0.67	0.027
California	4.4 - 5.7	0.044 – 0.057	0.018 – 0.023
California	3.1 - 6.6	0.031- 0.066	0.013 - 0.027

Long-term studies (27 years) of hunted and unhunted populations in Colorado indicate populations fluctuate widely among years, with no clear evidence of population cycles (Braun et al. 1993, Hoffman 2006). Table 2 displays the variability of breeding densities across the western United States.

Several studies support the evidence of weather as a key influence in the demography of white-tailed ptarmigan populations. Although factors such as hunting, habitat degradation by large ungulates, and pollution may reduce breeding densities in some areas, it is argued these factors are not general phenomena that regulate populations (Hoffman 2006). In addition, the opportunity for large population increases is limited because, compared to other grouse species, white-tailed ptarmigan produce relatively few young, even in a good production year, and turnover in the breeding population is low (Hoffman 2006). The relatively high survival rate of white-tailed ptarmigan apparently buffers against potential effects of perturbations on reproductions. It should also be noted the distribution of white-tail ptarmigan is not continuous, nor are all seemingly suitable habitats occupied (Hoffman 2006).

While the actual number of ptarmigan on the Carson National Forest is uncertain (albeit low), the species is still present and the population trend appears to be stable across the Forest. This trend is based on Braun's conclusion that the Pecos Wilderness population is established and there have been sightings of ptarmigan in all three areas over the years. Although ptarmigan are on the forest in low numbers, it was never expected the Carson National Forest would achieve large breeding populations, because of the limited amount of suitable habitat in the area. This confirms what the Forest Plan predicts of ptarmigan populations over the course of plan implementation – "…"habitat will be maintained or improved to at least provide habitat for minimum viable populations" (USDA 1986c, p. 238).

As previously described, white-tailed ptarmigan habitat on the Carson National Forest is in poor condition, but with a stable trend. Domestic sheep grazing has been eliminated in ptarmigan habitat, eventually contributing to willow recovery and subsequently improving trend over time, as documented in Braun's observations in 2006 (Braun 2006).

Impacts bighorn sheep and elk have on *Salix* should be considered in the management of these big game species. A management strategy for improving and expanding willow habitat should be developed and include a comparison study of the willow areas in Colorado, where ptarmigan populations are healthy. Willow plantings in areas where recovery has been slow or negligible might also improve habitat conditions.

REFERENCES

Braun, C. E. 1969. Documentation of the presence of white-tailed ptarmigan in Wheeler Peak and Latir Peak areas. Memorandum to Jack Grieb, Chief of Game Research, Colorado Department of Game, Fish, and Parks. November 21, 1969.

Braun, C. E. 1971. Habitat requirements of Colorado white-tailed ptarmigan. Proc. Western Assoc. St. Game & Fish Comms. 51:284-292, reprint.

Braun, C. E. 1979. White-tailed ptarmigan and sage grouse investigations, New Mexico. Memorandum to Jack R. Grieb, Director, Colorado Division of Wildlife. August 15, 1979.

Braun, C.E. 2006. White-tailed ptarmigan, Pecos Wilderness Area. Trip Report. Clait E. Braun, Grouse Inc. Unpublished paper. June 18, 2006.

Braun, C. E.; Hoffman, R. W.; Rogers, G. E. 1976. Wintering areas and winter ecology of white-tailed ptarmigan in Colorado. Special Report No. 38. State publication code W-R-S-38-76. Colorado Division of Wildlife.

Braun, C.E.; Martin K.; Robb, L.A. 1993. White-tailed ptarmingan (*Lagopus leucura)*. *In* The Birds of North America, No. 68 (A. Poole and F. Gill, Eds.). Philadelphia: The Academy of Natural Sciences; Washington, D.C.: The American Ornithologists' Union.

Ehrlich, Paul; Dobkin, David; Wheye, Darryl. 1988. The birder's handbook: A field guide to the natural history of North American birds. Simon and Schuster. New York, NY: 252.

Gardiner, Ron. 2002. Photo verification of ptarmigan in the Pecos Wilderness. Unpublished. Summer 2002.

Giesen, K. M.; Braun, C. E. 1992. Winter home range and habitat characteristics of white-tailed ptarmigan in Colorado. Wilson Bulletin 104: 263-272.

Hoffman, R.W. 2006. White-tailed ptarmigan (*Lagopus leucura*): a technical conservation assessment. [Online]. USDA Forest Service, Rocky Mountain Region. Available: http://ww.fs.fed.us/r2/projects/scp/assessments/whitetailedptarmigan.pdf [Accessed - July 1, 2006].

Hoffman, R.W.; Giesen, K.M. 1982. Demography of an introduced population of white-tailed ptarmigan. Canadian Journal of Zoology. 61(8): 1758-1763.

Martin, K.; Stacey, P.; Braun, C. 2000. Recruitment, dispersal, and demographic rescue in spatially-structured white-tailed ptarmigan populations. The Condor. 102: 503-516.

Natural Heritage of New Mexico. 2006. NM Biotics Source Feature Record [web application]. Available: http://nhnm.unm.edu/usfs/r3/bcd_eo_record.php (Accessed: April 24, 2006)

NatureServe Explorer: An online encyclopedia of life [web application]. 2010. Version 7.1. Arlington, Virginia, USA: NatureServe. Available: http://www.natureserve.org/explorer. (Accessed: March 15, 2011).

New Mexico Department of Game and Fish. 2006. BISON-M (Biota Information System of New Mexico): Biological database for New Mexico. NMDGF in cooperation with USDI BLM, USDI FWS, USDI Bureau of Reclamation, US Army Corps of Engineers, USDA Forest Service and University of New Mexico. Available: http://nmnhp.unm.edu/bisonm (Accessed: January 24, 2007).

Oldenettel, J. 2000. Ptarmigan surveys in northern New Mexico. Unpublished documentation.

Oldenettel, J. 2007. Website: http://hometown.aol.com (Accessed: January 11, 2007).

USDA Forest Service. 1970. Ptarmigan habitat survey – Pecos Wilderness. Memorandum to Forest Supervisor from Donald Duff, Wildlife Management Biologist, Santa Fe National Forest. Unpublished report. July 20, 1970.

USDA Forest Service. 1976. Documentation of ptarmigan sitings in Main Fork Allotment. Documentation by Robert Runnels, Range Conservationist. Carson National Forest. Unpublished report. September 15, 1976.

USDA Forest Service. 1984. White-tailed ptarmigan monitoring. A Report to the Las Vegas District Ranger, Santa Fe National Forest by D. DeLorenzo. Unpublished report. January 11, 1984.

USDA Forest Service. 2006a. White-tailed ptarmigan training with Clait Braun, 6-12-06 to 6-14-06. Unpublished documentation by Matthew McDonald.

USDA Forest Service. 2006b. White-tailed ptarmigan survey of Little Costilla Peak, Valle Vidal. August 2006. Unpublished documentation by Matthew McDonald and Jack Carpenter.

Vines, R. 1960. Trees, shrubs and woody vines of the southwest. Austin, TX and London, UK: University of Texas Press: 106-112.

Wolfe, D.H. 2006. Nesting documentation for the white-tailed ptarmigan in the Sangre de Cristo Mountains, New Mexico. Publications of the Oklahoma Biological Survey 2nd Series, Volume 7: 21-23. 2006.

Resident Trout

INDICATOR SPECIES HABITAT

Resident trout species are used as indicator species for quality perennial streams and riparian vegetation (USDA 1986a, p.97). Resident populations reproduce and sustain themselves in the wild. Defined also as “resident trout” in the Carson Forest Plan are the rainbow trout (*Oncorhynchus mykiss*), brown trout(*Salmo trutta*), brook trout (*Salvelinus fontinalis)*, and Rio Grande cutthroat trout (*Oncorhynchus clarki virginalis*). Rio Grande cutthroat trout (RGCT) is the only native species with the other species being non-natives that have been stocked extensively in northern New Mexico over the past 100 years.

Rainbow trout was first introduced into New Mexico in 1896. Since that time, the rainbow trout has been introduced extensively into all major drainages of the state (Sublette et al. 1990). Rainbow trout prefer cool, clear lakes and cool, swift streams, with rocky substrates and a pool-to-riffle ratio of approximately 1:1. Overhanging vegetation on banks, deep pools, submerged vegetation, log jams, boulders, etc., in various combinations, are essential habitat components for escape and resting cover. This trout species prefers small streams to be shaded by up to 50 to 75 percent of canopy cover or have adequate undercut banks to reduce and stabilize water temperature. Deep, low velocity pools are important for overwintering. Rainbow trout tolerates a range of fresh water conditions, including temperature from 0 – 28.3 centigrade (C) and pH from 5.8 – 9.6. Adult rainbows avoid permanent residence in water temperatures above 18 C, with lethal temperatures around 25 C.

Brown trout is native to Europe and western Asia. It was first introduced into the United States in 1883 and now occurs widely throughout much of the United States and Canada (Sublette et al. 1990). It was introduced into most major drainages of New Mexico during the early 1900s. Brown trout inhabits small to large coldwater streams and lakes. The species tends to occupy deeper, lower velocity and warmer waters than other trout. A canopy shade of 50 to 75 percent is best to maintain habitat temperatures. Optimal temperatures for brown trout are 12 to 19 C. Lethal temperature for adults is about 27 C. Brown trout preys upon other species of trout and competes with them for food and living space.

Brook trout is native to eastern Canada and northeastern United States and has been introduced widely throughout much of North America (Sublette et al. 1990). Brook trout was introduced into most major drainages of New Mexico during the early 1900s. Brook trout adapts well to a variety of stream and lake environments. It is found primarily in cold, clear headwater streams, but also lives in cold lakes. Distribution is mainly controlled by water temperature (Raleigh 1982). The preferred temperature is 13.9 – 15.6 C. The species does poorly in waters warmer than 20 C for an extended time and 25 C is considered lethal.

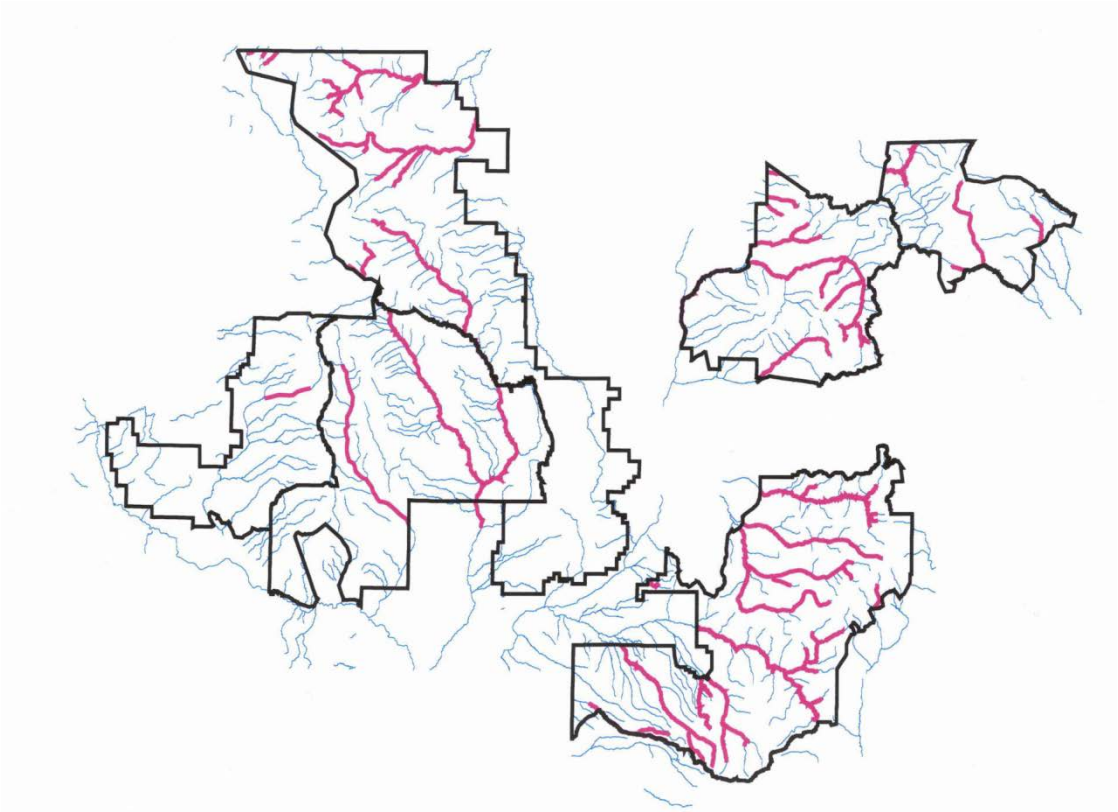
Rio Grande cutthroat trout’s (RGCT) historic range is not known, although it likely encompassed all waters presently capable of supporting trout in the Rio Grande drainage. The distribution of the Rio Grande cutthroat trout has declined to 9 percent of its former range in New Mexico (Duff 1996). Currently, the species is restricted primarily to headwater tributaries within its historic range. Populations of this subspecies in New Mexico inhabit isolated headwaters of three major drainages. Of these, the Rio Grande drainage has the most populations with 63 in the Sangre de Cristo Mountains, 13 in the Jemez Mountains, 4 in the San Juan Mountains, and one in the Black Range (Sublette 1990).

RGCT prefers clear, cold streams, with deep pools and consistent water flow, as well as, lakes. Population densities are regulated mostly by stream size and morphology (Koster 1957).

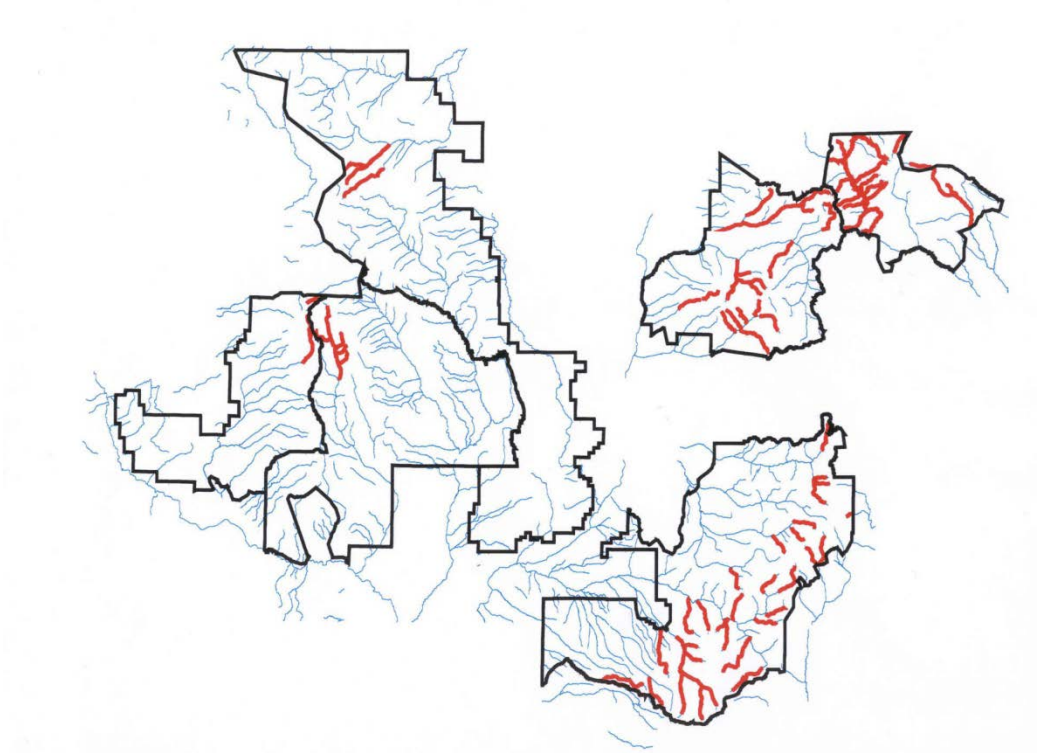
Deeper pools provide overwintering habitat, and consistent flows are important. Stream productivity is a reflection of general water quality. Substrates with clean gravels of various sizes and with little embeddedness provide for macroinvertebrate production as a consistent food source. Clean gravel substrates are also important for successful cutthroat reproduction. Undercut banks and large woody debris anchored throughout the stream course provide summer cover for predator avoidance (Sublette et al. 1990). Preferred water temperatures for the RGCT are between 5 and 16.5 C. Optimum habitat includes the absence of and protection from non-native trout species, such as brown, rainbow, and brook trout.

Potential Habitat Distribution

Approximately 440 miles of perennial stream on the Carson National Forest is known habitat for resident trout (Forest GIS Stream Inventory 2002). Rainbow, brown or brook trout occupy about 50 percent (~225 miles) of that habitat (Map 1) along with ~ 50 miles of stream that is also occupied by Rio Grande cutthroat trout. Approximately 269 miles of perennial stream on the Carson National Forest is known habitat for the Rio Grande cutthroat trout (Map 2) and 190 miles is potential habitat (Forest Inventory GIS Data 2002).



Map 1. Rainbow, Brown, Brook Trout and Overlap Rio Grande Cutthroat Trout Habitat Distribution on the Carson National Forest (Forest Inventory GIS Data 2002)



Map 2. Rio Grande Cutthroat Trout Habitat Distribution on the Carson National Forest (Forest Inventory GIS Data 2002)

Management Activities or Natural Events That May Affect Habitat

Negative:

Whirling Disease

Whirling disease was first detected in New Mexico in 1988 in rainbow trout imported into private ponds in the Moreno Valley in northern New Mexico. Whirling disease is a parasite that causes fish to swim erratically (whirl), and have difficulty feeding and avoiding predators. In severe infections, the disease can produce high rates of mortality in young-of-the-year fish. Water temperature, fish species and age, and dose of exposure are critical factors influencing whether infection will occur and its severity (USDI 2002).

Trout native to the United States did not evolve with whirling disease. Consequently, most native species have little or no natural resistance. All of the resident trout on the Carson National Forest are threatened by whirling disease, with the Rio Grande cutthroat and rainbow trout being the most severely impacted. The parasite has now been confirmed in three drainages that support resident trout: South Fork Rio Grande, Rio Grande, and Conejos. It is likely the parasite will continue to spread to more and more streams, as animals and humans easily transport the spores. In New Mexico all whirling disease positive fish are destroyed.

Overutilization

Angler pressure can impact rainbow, brown, and brook trout populations in localized areas. There is no commercial fishing for resident trout. Angling for all resident trout is regulated by the New Mexico Department of Game and Fish, with reduced bag limits and/or “catch and release” for RGCT. Because regulations in New Mexico allow trout fishing, recreational angling is not considered a threat to the species.

Catastrophic Events

Wildfires are a natural disturbance in forested watersheds. Historically, fires occurred every 4-5 years (Swetman 1990), and burned the understory leaving open stands of older trees. Fire suppression has resulted in large increases in fuel loads and high understory densities. As a result, under the right conditions, wildfires today can spread rapidly and burn intensely. In the Southwest, the fire season (May to June) is followed by the monsoon season (July to August). Consequently, denuded watersheds can be hit by heavy precipitation leading to floods and ash flows in streams.

Long-term drought can affect existing populations of resident trout as well. Water is becoming scarce in some reaches of the Carson National Forest, as streams experience nearly 7 years of drought.

Non-native Trout

The introduction of non-native trout species has had a negative effect on native trout, such as the Rio Grande cutthroat trout. Current resident trout populations occupy most of the historic "trout" waters.

Habitat loss

Degradation and alteration of trout habitat has occurred from activities such as road building, grazing, recreation, irrigation, and dam development. These activities can result in sedimentation, increased fluctuation in temperatures, less woody debris, and unnatural flow rates. Changes in water quality parameters such as low pH, high temperatures, and persistent sedimentation are detrimental to resident trout. The drought conditions on the Carson National Forest during the late 1990's through 2004 have resulted in some temporary habitat loss for these species.

Positive: Enhancement of riparian habitats and upland watersheds through proper grazing management, road closures, stream habitat structures, and the application of best management practices benefit all resident trout. The development of the Long-range Plan for the Management of the Rio Grande Cutthroat Trout in New Mexico (NMDGF 2002b) has benefited this species. Fish barriers are viewed as a short-term protection, with the ultimate goal of protecting additional stream miles and drainages. Other management activities which benefit only RGCT include: mechanically removing non-native trout in mixed composition populations and restoring habitat and reintroducing populations within historic ranges.

Plans, Regulations and Guidelines Supporting, Maintaining or Improving Habitat

- *Carson National Forest Land and Resource Management Plan, Forest-wide Wildlife and Fish* include standards and guidelines for Rio Grande cutthroat trout, as well as coldwater fisheries, fish passage, trout fisheries capacity and riparian vegetation (USDA 1986c, Wildlife & Fish Habitat).

  RIO GRANDE CUTTHROAT TROUT… Continue activities to improve Rio Grande Cutthroat habitat with the objective of securing the species. Develop Rio Grande Cutthroat trout fisheries within selected areas identified in conjunction with the New Mexico Department of Game and Fish (Wildlife & Fish Habitat – 4).

  RIPARIAN WOODY VEGETATION... On wet meadows and other riparian areas, favor the establishment of woody riparian vegetation as defined in FSH 2509.23. Control livestock and wildlife grazing through management and/or fencing to allow for adequate establishment of vegetation and the elimination of overuse (Wildlife & Fish Habitat – 12).

EXOTIC SPECIES... Manage in cooperation with NMDG&F for indigenous fauna. Exotic species will not be introduced. Unapproved exotics which become established on National Forest System Lands will be managed toward the goal of elimination (Wildlife & Fish Habitat – 13).

POPULATIONS... Cooperate with NMDG&F and other agencies to maintain wildlife and fish populations within identified habitat capabilities (Wildlife & Fish Habitat – 13).

COLD WATER FISHERIES... Inventory, evaluate, and improve areas of streams, lakes, and wetlands for coldwater fish, especially the Rio Grande cutthroat trout (Wildlife & Fish Habitat – 13).

FISH PASSAGE... Provide for fish passage under all roads crossing perennial streams (Wildlife & Fish Habitat – 13).

TROUT FISHERIES CAPACITY... Increase carrying capacity for put-and-take and wild trout fisheries through the installation of stream improvement structures, including the use of beaver to build and maintain beaver dams (Wildlife & Fish Habitat – 13).

RIPARIAN VEGETATION... Inventory riparian vegetation conditions and manage to achieve acceptable riparian standards. Direct habitat improvements may include planting, seeding, fencing, and rejuvenation of woody vegetation through selective cutting and burning (Wildlife & Fish Habitat – 13).

Standards and Guidelines for **Management Area 14--Riparian** include, "(m)anage for these indicator species: resident trout (cutthroat)…" (USDA 1990, p. 4. Pine <40% - 1, 5. MC/PP >40% - 1, 7. Unsuitable - 1).

- *Record of Decision for Amendment of Forest Plans* (1996) provides guidelines relative to the management of both Mexican spotted owl and northern goshawk habitat. In Riparian Areas "(e)mphasize maintenance and restoration of healthy riparian ecosystems through conformance with forest plan riparian standards and guidelines. Management strategies should move degraded riparian vegetation toward good condition as soon as possible. Damage to riparian vegetation, stream banks, and channels should be prevented." (USDA 1996, p. 90)

- *Long Range Plan for the Management of the Rio Grande Cutthroat Trout in New Mexico* (2002) developed by the New Mexico Department of Game and Fish provides guidance to agencies, conservation groups and interested individuals on future management actions related to the Rio Grande cutthroat trout in New Mexico (NMDGF 2002b).

- *Wild and Scenic Rivers Act* (1968) and *Amendment 12 of the Carson Forest Plan* (2002) give interim management of inventoried eligible rivers on the Carson National Forest. Pending a Wild and Scenic "suitability" determination or a recommendation for or against designation, protective management requirements (subject to valid existing rights and site-specific environmental analysis) ensure the eligible river segments on the Carson National Forest protection for their outstandingly remarkable values. In many cases the outstandingly remarkable value for which a river segment is eligible is the ability to support and maintain existing Rio Grande cutthroat populations.

- *Clean Water Act* (amended 1972 & 1987)

- *Outstanding National Resource Waters* (ONRW) designation of the streams within Valle Vidal of the Carson National Forest incorporates the Antidegradation Policy, which is referenced in the NM Water Quality Standards (20.6.4.8 NMAC). The policy states, "No degradation shall be allowed in high quality waters designated by the Commission as outstanding national resource waters." The Antidegradation Implementation Procedures

establishes three categories of waters, called “tiers”. The tier designation requires different levels of review and allows different levels of degradation. Waters designated as ONRW are assigned a “tier 3” designation.

HABITAT CONDITION AND TREND ON THE CARSON NATIONAL FOREST

Rainbow, brook, and brown trout tend to have a wider range of tolerance for habitat conditions than the Rio Grande cutthroat trout; therefore they are more widely distributed. Sedimentation of the substrate reduces spawning habitat and is usually caused by various activities, such as road building, grazing, fire, irrigation, etc. Overall, most areas of the Carson National Forest that are occupied by resident trout and may be supplemented by stocking appear to be in good or stable condition. Stream habitat surveys are currently ongoing to make a qualified determination of overall conditions and trend.

Road systems are the primary source of sedimentation in streams on the Forest. Although affected streams may still be suitable, they are less than optimal trout habitat. Other factors that reduce habitat quality include domestic livestock grazing, which can destroy overhanging banks and increase sedimentation, and diversions of water for irrigation, which can significantly reduce the amount of water in a stream system. Mining has impacted specific sites. Dewatering and sedimentation are the two most prevalent factors affecting habitat conditions (Duff 1996).

Timber harvest and associated road building have led to the deterioration of trout habitat; however timber harvest on National Forests has declined appreciably in the last 16 years. From 1986 to 1990 the Carson National Forest averaged 25.5 million board feet (MMBF) per year of timber cutting. From 1991 to 2001 the average was 7.1 million board feet – a decline of 72 percent in volume. Few new roads are built in conjunction with timber harvest, since the existing infrastructure can be used. Any new road construction is usually for moving an existing portion of road out of a sensitive area, such as riparian vegetation along stream banks. Roads are being decommissioned and obliterated each year, reducing their contribution to sedimentation of streams. In the 1990’s the Carson National Forest decommissioned 70 to 100 miles of road per year. Since 2000, the Forest has decommissioned an average of 25 miles per year. Many of the current pure, stable, and secure populations of RGCT occur at elevations where timber harvest has not occurred, thus their habitat has not been affected.

Livestock grazing practices on public land in New Mexico have significantly improved over the last century. Changing livestock stocking levels and improved management practices have occurred and will continue to occur following current management direction. Restoration of riparian areas and maintaining healthy habitat is a priority for the Carson National Forest, as well as the Southwestern Region (USDI 2002, NMDGF 2002b).

NM Department of Game and Fish and Forest Service biologists have assessed habitat condition in streams with pure, stable and secure populations of RGCT (NMDGF 2002b). Habitat condition was rated using the following classification:

0	no habitat problems
0-1	headwater reaches are in good condition & lower reaches have problems in discrete areas
1	some problems identified (sedimentation, lack of pools, warm water temperature, heavy metals, etc.)
2	pervasive problems related to RGCT habitat identified

Table 1

In most instances, sedimentation and problems related to livestock grazing were identified as primary sources of habitat degradation. While streams that are rated with a "1" have some level of habitat degradation that probably prevents populations from reaching maximum reproductive capability, the degradation is not judged to be a threat to the existence of any of the populations (USDI 2002). In most instances, stream habitat condition was rated between the ranges of 0 to 1, with very few streams rated as 2. Based on the outcome of these assessments for each stream, it is the opinion of the Forest Service and NMDGF that habitat problems are typically localized and can be or are being addressed through management practices.

Fish barriers are essential to separate RGCT from non-native trout. However, to be effective barriers must be checked and maintained. Flood events can blow a man-made barrier out, change the channel morphology permanently, or provide a temporary channel around the barrier that fish can use for upstream migration. Older gabion barriers (rocks in a wire basket) and culverts appear to be the most vulnerable structures. Changes in water velocity (either an increase or decrease depending on the situation) can change an impassable barrier into one that can be passed.

The Forest Service assesses barriers as part of its stream habitat inventory. Representative resident trout streams across the Carson National Forest were selected and a monitoring rotation developed to establish a monitoring regime. Habitat trend is developing as streams are revisited. Over 150 miles of stream have been inventoried for an array of habitat quality indicators since 2001 (see end of this section).

Comanche Creek has had habitat inventory completed twice since Valle Vidal was acquired by the Carson National Forest in 1983. The first survey was conducted in 1998 and it was again surveyed in 2005. Due to the improvement in management and the continued habitat restoration effort by the Forest and its many partners, comparison of the two surveys indicates the habitat to be stable, with an upward trend (USDA 2006.)

Land management practices have improved in recent years, with greater emphasis on habitat improvement. Although recovery of these habitats can be slow, the continued commitment to manage and restore watersheds will improve resident trout habitat over time. Physical habitat conditions related to forest management activities and **habitat trend for resident trout is stable**.

POPULATION TREND

Regional

Rainbow trout is the most widely cultured and stocked trout in North America and occurs across the majority of the United States and Canada. A number of stocked fish do survive in the stream habitats to become resident trout. The NatureServe database (NatureServe 2010) documents that throughout its range, rainbow trout is listed as "G5", (i.e., globally secure and common,

widespread and abundant). Reasons given for the G5 ranking are its large range and that it is common in many areas and there is no evidence of large-scale declines. It is not vulnerable in most of its range. Species with this rank typically occur in more than 100 localities, and there are more than 10,000 individuals. Within the United States, the rainbow trout is listed as "N5" (i.e., secure and common, widespread and abundant). In New Mexico, the rainbow trout is listed as "SNA" (Status Ranking not Applicable because this species is not a suitable target for conservation activities, i.e., exotic in the state/province).

The brown trout is an exotic species that now occurs in 44 of the lower 48 states being absent in several states in the extreme south and is also has a global rank of "G5" and a state rank "SNA".

The brook trout is uncommon in New Mexico and is an exotic in the western United States. It is native to the eastern United States and Canada and is ranked "G5". It also has a state rank of "SNA".

The Rio Grande cutthroat trout was once widespread in the upper Rio Grande and Canadian river basins of northern New Mexico and south-central Colorado (Sublette et al. 1990). The historic range of RGCT has been greatly reduced over the last 150 years (USDI 2002). In response to the RGCTs decline, various non-native trout species were stocked in the state's rivers, lakes, and streams since the late 1800's. Generally, the introduced trout species will out-compete the native cutthroat for food and space (Sublette et al. 1990). Rio Grande cutthroat also readily hybridizes with other spring spawning trout, such as rainbow trout and a subspecies of cutthroat trout (*O. clarki*), contaminating the genetics of pure RGCT populations (Sublette et al. 1990). Many populations have been lost or impacted by water diversions, dams, habitat degradation, changes in hydrology, hybridization with rainbow trout, or competition with brown or brook trout.

The NatureServe database lists cutthroat trout as "G4", which means that the species (not limited to the subspecies "Rio Grande cutthroat trout") is uncommon but not rare (although it may be rare in parts of its range, particularly on the periphery), and usually widespread. Typically more than 100 occurrences and more than 10,000 individuals exist in its range. The Rio Grande cutthroat trout is ranked "T3". Reasons given for this ranking are: 1) its small range in the Rio Grande drainage of Colorado and New Mexico; 2) approximately 200 extant populations; 3) favorable protection and management in place; and 4) secure and likely to improve in status with active management.

New Mexico

The rainbow and, to a lesser degree, the brown trout have been stocked historically and are currently stocked in northern New Mexico. The occurrence of whirling disease in hatcheries has significantly reduced the current stocking levels. In 2005, stocking levels were up to about 80% of the levels prior to the discovery of whirling disease in the state.

Based on Performance Reports, from 1997 through 2004, as required by the Federal Aid in Sport Fish Restoration act, resident trout populations fluctuate based on water levels and habitat availability due to water fluctuations (NMDGF 1998-2004). In stream systems where flows are more constant, populations are expected to remain constant.

In New Mexico, the RGCT is listed as "S2" (i.e, imperiled in the state because of rarity due to very restricted range, very few populations (often 20 or fewer), steep declines, or other factors making it very vulnerable to extirpation from the state/province). Currently, 106 populations of

Rio Grande cutthroat trout are estimated in New Mexico (NMDGF 2002b) and 161 in Colorado (USDI 2002) in both streams and lakes (USDI 2002). Additionally, 120 separate RGCT populations occupying 690 miles of habitat have been identified and designated as "conservation populations". These conservation populations are spread throughout the historical range, occurring in 14 of the 19 hydrologic units historically occupied by RGCT.

Carson National Forest

Rainbow, brown, and brook trout can be found in the streams shown in Map 1 (covering ~225 miles of streams). The New Mexico Department of Game and Fish continues to stock these species in various locations on the Forest (NMDGF 2006 personal contact).

There are approximately 57 tributaries on the Carson National Forest that contain RGCT populations. These streams are systematically being checked for purity of genetics. Approximately 30 streams or tributaries have Class A or B populations – the highest ratings for genetic purity. During the last decade, approximately 35 miles of RGCT streams have been restored or improved by removal of non-native species and either construction or improvement of migration barriers.

Table 1. Streams Actively Managed for RGCT on the Carson National Forest

Stream	Ranger District
East Fork Santa Barbara	Camino Real
Middle Fork Santa Barbara	Camino Real
Jicarita Creek	Camino Real
West Fork Luna Creek	Camino Real
Frijoles Creek	Camino Real
Policarpio Creek	Camino Real
Upper Rito La Pressa	Camino Real
Comanche Creek	Questa
Powderhouse Canyon	Questa
Leandro Creek	Questa
Middle Ponil Creek	Questa
El Rito Creek	El Rito
Canada Tio Grande	Tres Piedras
Tanques Canyon	Tres Piedras

Thirteen populations were identified as pure (confirmed by appropriate genetic testing), have over 2,500 fish, are secured by a barrier, and do not coexist with non-natives. Table 2 displays streams with pure, stable and secure populations of Rio Grande cutthroat trout on the Carson National Forest.

Table 2. Pure and Stable RGCT Populations on Carson National Forest

Stream	Ranger District
El Rito Creek	El Rito
Bitter Creek	Questa
Columbine Creek	Questa
Leandro Creek	Questa

Stream	Ranger District
McCrystal Creek	Questa
San Cristobal Creek	Questa
South Fork of Rio Hondo	Questa
Powderhouse Creek	Questa
Policarpio Creek	Camino Real
Rito Angostura	Camino real

Although unrelated to forest management activities, resident trout has likely lost some populations due to the recent drought years and drying up of some head waters. These can likely recover over time.

Given the nature of trout stocking on the Carson National Forest, the population trend for resident trout species is stable. This does not necessarily confirm what the Forest Plan predicts of resident trout populations over the course of plan implementation – "…populations are expected to increase because of improved habitat condition" (USDA 1986c, p. 238). Although population surveys for all resident trout have been conducted and are continuing, stocking programs can overshadow apparent trend data in areas where stocking takes place. Since the preparation of the 2003 MIS assessment, over 20 stream systems have been inventoried or reinventoried.

REFERENCES

Duff, Donald A., tech ed. 1996. Conservation assessment for inland cutthroat trout: distribution, status and habitat management implications. General Technical Report RM-GTR-256. Ogden, UT: US Department of Agriculture, Forest Service, Intermountain Region. 120 p.

Harig, A.L.; Fausch, K.D. 1999. Minimum habitat requirements for establishing translocated cutthroat trout populations. Annual Progress Report to Colorado Division of Wildlife, US Forest Service and Trout unlimited.

Koster, William J. 1957. Guide to fishes of New Mexico. Albuquerque, NM: University of New Mexico Press in Cooperation with New Mexico Department of Game and Fish: 29-30.

NatureServe Explorer: An online encyclopedia of life [web application]. 2010. Version 7.1. Arlington, Virginia, USA: NatureServe. Available: http://www.natureserve.org/explorer. (Accessed: March 16, 2011 for Brrok, Brown, Rainbow, and Rio Grande Cutthroat Trout).

New Mexico Department of Game and Fish. 1998. Investigations of trout management strategies. Final Report, 6 May, 1998: Grant F-60-M/Project 13. Santa Fe, NM: New Mexico Department of Game and Fish. 22 p.

New Mexico Department of Game and Fish. 1999. Investigations of trout management programs. Performance Report, 22 February, 1999: Grant F-60-M/Project 6. Santa Fe, NM: New Mexico Department of Game and Fish. 7 p.

New Mexico Department of Game and Fish. 2000. Investigations of trout management programs. Performance Report, 19 September, 2000: Grant F-60-M-7/Project 06. Santa Fe, NM: New Mexico Department of Game and Fish. 7 p.

New Mexico Department of Game and Fish. 2001. Investigations of trout management programs. Performance Report: Grant F-60-M/Project 06. Santa Fe, NM: New Mexico Department of Game and Fish. 34 p.

New Mexico Department of Game and Fish. 2002a. Investigations of trout management programs. Performance Report: Grant F-60-M-7/Project 06. Santa Fe, NM: New Mexico Department of Game and Fish. 4 p.

New Mexico Department of Game and Fish. 2002b. Long range plan for the management of the Rio Grande cutthroat trout in New Mexico. Santa Fe, NM: New Mexico Department of Game and Fish.

New Mexico Department of Game and Fish. 2003. Long range plan for the management of the Rio Grande cutthroat trout in New Mexico. Santa Fe, NM: New Mexico Department of Game and Fish.

New Mexico Department of Game and Fish. 2004. Long range plan for the management of the Rio Grande cutthroat trout in New Mexico. Santa Fe, NM: New Mexico Department of Game and Fish.

New Mexico Department of Game and Fish. 2007. BISON-M (Biota Information System of New Mexico): Biological database for New Mexico. NMDGF in cooperation with USDI BLM, USDI FWS, USDI Bureau of Reclamation, US Army Corps of Engineers, USDA Forest Service and University of New Mexico. Available: www.bison-m.org (Accessed: 21 March 2007 for Brown, Brook, Rainbow, and Rio Grande Cutthroat Trout).

New Mexico Department of Game and Fish. 2006. Personal Contact with Eric Frey, Northeast Area Fisheries Manager. Raton, NM: New Mexico Department of Game and Fish.

Raleigh, R.F. 1982. Habitat suitability index: Brook trout. FUS/OBS-82/10.24. USDI Fish and Wildlife Service. 42 p.

Sublette, James; Hatch, Michael D.; Sublette, Mary. 1990. The fishes of New Mexico. Albuquerque, NM: University of New Mexico Press. 393 p.

USDA Forest Service. 1994. Fish monitoring on the Carson National Forest. Taos, NM: US Department of Agriculture, Forest Service, Southwestern Region, Carson National Forest. Unpublished report.

USDA Forest Service. 1995. Fish monitoring on the Carson National Forest. Taos, NM: US Department of Agriculture, Forest Service, Southwestern Region, Carson National Forest. Unpublished.

USDA Forest Service. 1996. Fish monitoring on the Carson National Forest. Taos, NM: US Department of Agriculture, Forest Service, Southwestern Region, Carson National Forest. Unpublished report.

USDA Forest Service. 1997. Fish monitoring on the Carson National Forest. Taos, NM: US Department of Agriculture, Forest Service, Southwestern Region, Carson National Forest. Unpublished report.

USDA Forest Service. 1998. Fish monitoring on the Carson National Forest. Taos, NM: US Department of Agriculture, Forest Service, Southwestern Region, Carson National Forest. Unpublished report.

USDA Forest Service. 1999. Fish monitoring on the Carson National Forest. Taos, NM: US Department of Agriculture, Forest Service, Southwestern Region, Carson National Forest. Unpublished report.

USDA Forest Service. 2000. Fish monitoring on the Carson National Forest. Taos, NM: US Department of Agriculture, Forest Service, Southwestern Region, Carson National Forest. Unpublished report.

USDA Forest Service. 2001. Fish monitoring on the Carson National Forest. Taos, NM: US Department of Agriculture, Forest Service, Southwestern Region, Carson National Forest. Unpublished report.

USDA Forest Service. 2002. Fish monitoring on the Carson National Forest. Taos, NM: US Department of Agriculture, Forest Service, Southwestern Region, Carson National Forest. Unpublished report.

USDA Forest Service. 2003. Fish monitoring on the Carson National Forest. Taos, NM: US Department of Agriculture, Forest Service, Southwestern Region, Carson National Forest. Unpublished report.

USDA Forest Service. 2006. Comanche Creek stream habitat inventory report Carson National Forest, Taos New Mexico. Unpublished document.

USDA Forest Service. 2007. Management indicator species for the Carson National Forest – June 2007. Unpublished. 169 p.

USDI Fish and Wildlife Service. 1998. Endangered and threatened wildlife and plants: 90-day finding for a petition to list the Bonneville Cutthroat Trout as threatened. December 8, 1998 Federal Register 63(235): 67640-67642.

USDI Fish and Wildlife Service. 2002. Endangered and threatened wildlife and plants: candidate status review for Rio Grande cutthroat trout. June, 11 2002 Federal Register 67(112): 39936-39947.

Aquatic Macroinvertebrates

INDICATOR SPECIES HABITAT

Aquatic macroinvertebrates or aquatic insects are found in lakes, streams, ponds, marshes and puddles and help maintain the health of the water ecosystem by eating bacteria and dead, decaying plants and animals. Local populations of certain aquatic macroinvertebrates are indicator species of high quality water. They are indicator of overall aquatic conditions, quality of fisheries and associated riparian habitat (USDA 1986a, p.97). For the purpose of analyzing the effects of forest management activities, the primary habitat requirement for aquatic macroinvertebrates is perennial water which supports resident trout.

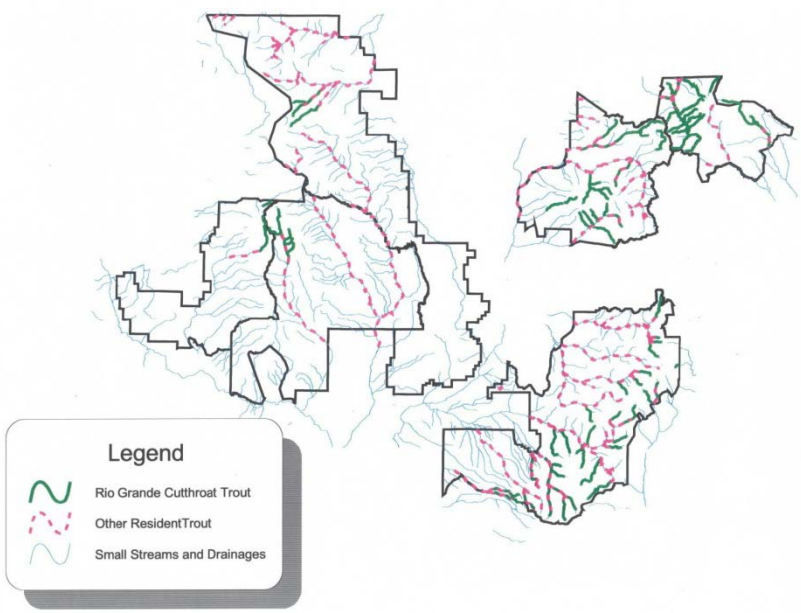
However, many environmental factors and their interactions determine the composition and abundance of stream insects. In natural perennial streams, the key controlling factors are temperature, discharge/current, substrate, chemical conditions and aquatic/riparian vegetation. Overall, it is the water quality that effects which types of organisms can survive in a body of water. Water quality may include the amounts of dissolved oxygen and the levels of algal growth, pollutants, which may be present, and the pH level.

Aquatic insects collectively show a wide range of tolerance to environmental conditions. Riparian vegetation conditions, temperature, hydraulics and substrate composition all change under natural conditions and in response the aquatic invertebrate communities generally reflect those changes. Various locations within a stream are likely to also have a range of conditions that dictate which aquatic invertebrate species are found there. Some taxa or species are more tolerant or have a wider range of acceptable habitat conditions than others.

Some macroinvertebrates such as stoneflies, mayflies, and water pennies require a high level of dissolved oxygen and their abundance is an indication of good water quality. Other macroinvertebrates can survive at a lower dissolved oxygen level because they can come to the surface to get oxygen through a breathing or "snorkel" tube or carry a bubble of air with them around their bodies or under their wings.

Potential Habitat Distribution

Approximately 440 miles of perennial stream on the Carson National Forest is known habitat for aquatic macro invertebrates (Map 1, Forest GIS Stream Inventory 2002).



Map 1. Aquatic Macroinvertebrate Potential Habitat Distribution on the Carson National Forest (USDA 2002)

Management Activities or Natural Events That May Affect Habitat

Negative: Taxa that are less tolerant of impacts (*Ephemeroptera*, *Plecoptera*, *Trichoptera*) affected by habitat degradation and alteration from activities such as road building, grazing, mining, and dewatering.

Positive: Improvement of riparian habitats and upland watershed conditions through proper grazing practices, road maintenance, and the application of best management practices when implementing ground disturbing activities near perennial streams.

Plans, Regulations and Guidelines Supporting, Maintaining or Improving Habitat

- *Carson National Forest Land and Resource Management Plan, Forest-wide Wildlife and Fish* standards and guidelines:

  ROAD MANAGEMENT… Emphasize road management and resource/wildlife protection as a primary Forest policy (USDA 1986c, p. Wildlife & Fish –10).

  RIPARIAN WOOD VEGETATION… On wet meadows and other riparian areas, favor the establishment of woody riparian vegetation as defined in FSH 2509.23. Control livestock and wildlife grazing through management and/or fencing to allow for adequate establishment of vegetation and the elimination of over use (USDA 1986c, p. Wildlife & Fish –12)

  The desired condition for Management Area 14 – Riparian is described as a stable fish population along the shaded, healthy stream and lake bottom, with diverse aquatic species. Manage for these indicator species: resident trout (cutthroat), hairy woodpecker, aquatic macroinvertebrates, elk (USDA 1986c, Management Area Prescriptions for MA 14 Riparian-1 & 3).

- *Record of Decision for Amendment of Forest Plans* (1996) provides guidelines relative to the management of both Mexican spotted owl and northern goshawk habitat. In Riparian

Areas "(e)mphasize maintenance and restoration of healthy riparian ecosystems through conformance with forest plan riparian standards and guidelines. Management strategies should move degraded riparian vegetation toward good condition as soon as possible. Damage to riparian vegetation, stream banks, and channels should be prevented." (USDA 1996, p. 90)

- *Clean Water Act* (amended 1972 & 1987)

- *Outstanding National Resource Waters* (ONRW) designation of the streams within Valle Vidal of the Carson National Forest incorporates the Antidegradation Policy, which is referenced in the NM Water Quality Standards (20.6.4.8 NMAC). The policy states, "No degradation shall be allowed in high quality waters designated by the Commission as outstanding national resource waters." The Antidegradation Implementation Procedures establishes three categories of waters, called "tiers". The tier designation requires different levels of review and allows different levels of degradation. Waters designated as ONRW are assigned a "tier 3" designation.

HABITAT CONDITION AND TREND ON THE CARSON NATIONAL FOREST

In the 1986 Forest Plan EIS, the available habitat for both resident trout and macroinvertebrates was based on the total length of stream miles (estimated at 400 miles) on the Carson National Forest (USDA 1986a, p. 97). As discussed in the *Resident Trout* section of this assessment, data processing and GIS abilities has refined the amount of habitat to 444.26 miles.

Since 2001, the Carson National Forest has been conducting stream habitat inventories on designated streams across the forest. One of the parameters measured is substrate composition, which is an indicator of habitat quality for macroinvertebrates. Baseline data is still being collected. **Based on the available data, the trend in available habitat is stable.**

Railroad logging in the early 1900's was one of the most significant events that affected stream systems on the Carson National Forest. Riparian conditions were seriously impacted by the use of tie staging along the streams. And the stream conditions were devastated as they were channelized to float cross-ties down to the Rio Grande. Over the next several decades, the watershed conditions rapidly eroded due to the lack of any herbaceous ground cover on the canyon slopes. By the mid-1900's, the federal government had gradually acquired lands into the National Forest System, that were once privately owned by logging companies. Riparian areas and stream conditions improved as managed grazing systems were established, watershed restoration projects were implemented (which began as early as 1933), roads were closed and obliterated, and logging practices changed.

Today, road systems are the primary source of sedimentation in streams on the Forest. Although affected streams may still be suitable, they are less than optimal for aquatic macroinvertebrates that require high water quality. Other factors that reduce habitat quality include domestic livestock grazing, which can destroy overhanging banks and increase sedimentation, and diversions of water for irrigation, which can significantly reduce the amount of water in a stream system. Dewatering and sedimentation are the two most prevalent factors affecting habitat conditions (Duff 1996).

Habitat conditions on the Carson National Forest vary by stream and by location within the stream. Overall, most habitats appear able to support diverse communities of aquatic macroinvertebrates. Stream habitat surveys, which are ongoing, will better qualify conditions in

specific streams over time. Since the implementation of the Carson Forest Plan in most areas of the forest, physical condition of aquatic habitat appears to be stable or improved.

POPULATION TREND AND VIABILITY

Macroinvertebrate communities are used to display changes from management activities or natural effects and can decline or recover quickly or in the long-term, depending on the type and duration of the impact. Overall, diverse communities of aquatic macroinvertebrates are represented Forest-wide, and are considered stable unless an influence or significant event affects a local or given reach of stream. Most populations, however, can quickly recover.

Because of the volatile fluctuations that can occur in most aquatic macroinvertebrate populations, trends by numbers are of little value unless long-term studies show persistent changes. Persistent absences or declines or in some cases appearances of certain benthic organisms may also indicate a change in aquatic health. **Population trends for aquatic macroinvertebrates on the Carson National Forest appear to be stable**, although additional time is necessary to determine a more reliable indication of trend.

Aquatic macroinvertebrate surveys and analysis have been conducted on several streams within the Forest. Representative streams and sample points within those systems have been selected for aquatic macroinvertebrate sampling. Initial baseline data was collected in 1982. Additional points were included and monitoring samples collected annually between 1997 and 2001. The following are the sampling locations on the Carson National Forest:

Table 1. Sampling Locations for Aquatic Macroinvertebrate Monitoring on the Carson National Forest

Station	Water Body	Segment	Ranger District
COMANCHE01	Comanche Creek	upstream from Clayton Camp	Questa
COMANCHE02	Comanche Creek	upstream from La Belle	Questa
COMANCHE03	Comanche Creek	upstream from Gold	Questa
COMANCHE04	Comanche Creek	0.5 miles downstream from Gold	Questa
COMANCHE05	Comanche Creek	upstream from Little Costilla	Questa
COMANCHE06	Comanche Creek	downstream from Little Costilla	Questa
COMANCHE07	Comanche Creek	downstream from Chuckwagon	Questa
COMANCHE08	Comanche Creek	at Comanche Point	Questa
COMANCHE20	Comanche Creek	within large exclosure	Questa
COMANCHE21	Comanche Creek	downstream from large exclosure	Questa
COMANCHE22	Comanche Creek	upstream from large exclosure	Questa
CWAGON-01	Chuckwagon Creek	0.25 miles upstream from mouth	Questa
ELRITO-A	El Rito Creek	1 mile upstream from barrier	El Rito
ELRITO-B	El Rito Creek	0.5 mile upstream from barrier	El Rito
ELRITO-C	El Rito Creek	0.5 mile downstream from barrier	El Rito
ELRITO-D	El Rito Creek	1 mile downstream from barrier	El Rito
ELRITO-E	El Rito Creek	upstream from campground	El Rito
ELRITO-F	El Rito Creek	at campground	El Rito
ELRITO-G	El Rito Creek	downstream from campground	El Rito
FERNANDZ01	Fernandez Creek	0.25 miles upstream from mouth	Camino Real
LITTCOST01	Little Costilla Creek	0.25 miles upstream	Questa

Station	Water Body	Segment	Ranger District
POT-01	Rito de la Olla	lower	Camino Real
POT-02	Rito de la Olla	middle	Camino Real
POT-03	Rito de la Olla	upper	Camino Real
POWDER-01	Powderhouse Creek	lower	Questa
POWDER-02	Powderhouse Creek	middle	Questa
POWDER-03	Powderhouse Creek	upper	Questa
RRBELOW	Red River	just downstream from town	Questa
RRDEBRIS	Red River	0.5 miles downstream from town	Questa
RRDOWNMINE	Red River	downstream from Molycorp	Questa
RRTOWN	Red River	in town	Questa
RRUPMINE	Red River	upstream from Molycorp	Questa
TIOGRAN-01	Tio Grande Creek	lower	Camino Real
TIOGRAN-02	Tio Grande Creek	middle	Camino Real
TIOGRAN-03	Tio Grande Creek	upper	Camino Real
VIDAL01	Vidal Creek	upstream from Clayton Camp	Questa

Appendix A is a summary of general assemblages of dominant families from the Aquatic Invertebrate Monitoring Report, Carson National Forest (Vinson 2002). Populations are generally represented by a diverse number of families and including those that show sensitivity to degraded aquatic systems and pollution.

Based on the highly fluctuating nature of macroinvertebrate organisms due to hatch timing, stream drift and other factors such as yearly variations in flow and water temperatures; it will likely take many years to determine actual trends. Apparent population trends are healthy and stable.

REFERENCES

Duff, Donald A., tech ed. 1996. Conservation assessment for inland cutthroat trout: distribution, status and habitat management implications. General Technical Report RM-GTR-256. Ogden, UT: US Department of Agriculture, Forest Service, Intermountain Region. 120 p.

Vinson, M. 1998. Aquatic benthic macroinverterbrate monitoring report, Carson National Forest. March 27, 1998. Logan, UT: Utah State University.

Vinson, M. 1999a. Aquatic macroinverterbrate monitoring report, Carson National Forest. January 8, 1999. Logan, UT: Utah State University.

Vinson, M. 1999b. Aquatic macroinverterbrate monitoring report, Carson National Forest. January 25, 1999. Logan, UT: Utah State University.

Vinson, M. 2000. Aquatic macroinverterbrate monitoring report, Carson National Forest. Novemer 3, 2000. Logan, UT: Utah State University.

Vinson, M. 2001a. Aquatic macroinverterbrate monitoring report, Carson National Forest. August 21, 2001. Logan, UT: Utah State University.

Vinson, M. 2001b. Aquatic macroinverterbrate monitoring report, Carson National Forest. November 26, 2001. Logan, UT: Utah State University.

Vinson, M. 2002a. Aquatic macroinverterbrate monitoring report, Carson National Forest. February 6, 2002. Logan, UT: Utah State University.

Vinson, M. 2003. Aquatic macroinverterbrate monitoring report, Carson National Forest. June 11, 2003. Logan, UT: Utah State University.

Vinson, M. 2004. Aquatic macroinverterbrate monitoring report, Carson National Forest. Logan, UT: Utah State University.

USDA Forest Service. 2003. Sawmill Creek habitat survey, 2001. Taos, NM: US Department of Agriculture, Forest Service, Southwestern Region, Carson National Forest. Unpublished report.

USDA Forest Service. 2003. Placer Creek habitat survey, 2002. Taos, NM: US Department of Agriculture, Forest Service, Southwestern Region, Carson National Forest. Unpublished report.

USDA Forest Service. 2003. Tio Grande habitat survey, 2002. Taos, NM: US Department of Agriculture, Forest Service, Southwestern Region, Carson National Forest. Unpublished report.

USDA Forest Service. 2004. Canjilon Creek habitat survey, 2001. Taos, NM: US Department of Agriculture, Forest Service, Southwestern Region, Carson National Forest. Unpublished report.

USDA Forest Service. 2004. Italianos Creek habitat survey, 2001. Taos, NM: US Department of Agriculture, Forest Service, Southwestern Region, Carson National Forest. Unpublished report.

USDA Forest Service. 2004. Manzanita Creek habitat survey, 2001. Taos, NM: US Department of Agriculture, Forest Service, Southwestern Region, Carson National Forest. Unpublished report.

USDA Forest Service. 2004. Tanques Creek habitat survey, 2001. Taos, NM: US Department of Agriculture, Forest Service, Southwestern Region, Carson National Forest. Unpublished report.

USDA Forest Service. 2004. Yerba Creek habitat survey, 2001. Taos, NM: US Department of Agriculture, Forest Service, Southwestern Region, Carson National Forest. Unpublished report.

USDA Forest Service. 2004. Capulin Creek habitat survey, 2002. Taos, NM: US Department of Agriculture, Forest Service, Southwestern Region, Carson National Forest. Unpublished report.

USDA Forest Service. 2004. Rio Fernando habitat survey, 2002. Taos, NM: US Department of Agriculture, Forest Service, Southwestern Region, Carson National Forest. Unpublished report.

USDA Forest Service. 2004. La Cueva Creek habitat survey, 2002. Taos, NM: US Department of Agriculture, Forest Service, Southwestern Region, Carson National Forest. Unpublished report.

USDA Forest Service. 2004. Lake Fork Creek habitat survey, 2002. Taos, NM: US Department of Agriculture, Forest Service, Southwestern Region, Carson National Forest. Unpublished report.

USDA Forest Service. 2004. Rio Chiquito habitat survey, 2002. Taos, NM: US Department of Agriculture, Forest Service, Southwestern Region, Carson National Forest. Unpublished report.

USDA Forest Service. 2004. Rio Grande del Rancho habitat survey, 2002. Taos, NM: US Department of Agriculture, Forest Service, Southwestern Region, Carson National Forest. Unpublished report.

USDA Forest Service. 2004. Warm Springs (Agua Caliente) habitat survey, 2002. Taos, NM: US Department of Agriculture, Forest Service, Southwestern Region, Carson National Forest. Unpublished report.

USDA Forest Service. 2005. McCrystal/ Ponil Creek habitat survey, 2004. Taos, NM: US Department of Agriculture, Forest Service, Southwestern Region, Carson National Forest. Unpublished report.

USDA Forest Service. 2006. Comanche Creek habitat survey, 2005. Taos, NM: US Department of Agriculture, Forest Service, Southwestern Region, Carson National Forest. Unpublished report.

USDA Forest Service. 2006. Middle Ponil Creek habitat survey, 2005. Taos, NM: US Department of Agriculture, Forest Service, Southwestern Region, Carson National Forest. Unpublished report.

USDA Forest Service. 2006. Rio Costilla Creek habitat survey, 2005. Taos, NM: US Department of Agriculture, Forest Service, Southwestern Region, Carson National Forest. Unpublished report.

Appendix -- Determining Habitat Trends

INTRODUCTION

The following are assessments of habitat trends of Management Indicator Species (MIS). The basis for determining trend is a comparison of estimated MIS habitats at the time of preparing the Forest Plan (USDAc 1986) to the present. The methods used to determine current habitats had to be developed to approximate similarity to the degree possible to the 1986 Forest Plan Environmental Impact Statement (USDAa 1986). In some cases the estimated acres of MIS habitats are base on certain parameters of habitat quality. The rationale and methods are described for each MIS or group.

Management indicator species are a subset of all animal and plant species in a planning area selected for planning and management purposes. Management indicator species are defined in the Carson Forest Plan as, “[t]hose species selected in the planning process to monitor the effects of planned management activities on viable populations of all wildlife and fish species, including those species that are socially or economically important” (USDA 1986c, Glossary p. 301). MIS are selected to represent several categories, such as commonly hunted or fished species, non-game and threatened and endangered species.

The 1986 Carson Forest Plan (USDA 1986a, p. 97) designates specific MIS with habitats that could best be used to analyze effects of site-specific proposals on the Carson National Forest. These species are:

Table 1

MIS	Habitat
Hairy woodpecker	snag
Turkey	old growth pine
White-tailed ptarmigan	alpine tundra, subalpine deciduous shrub
Plain titmouse	pinon-juniper canopies
Brewer's sparrow	sagebrush
Abert's squirrel	interlocking canopies
Red squirrel	mixed conifer
Elk	general forest
Bighorn sheep	alpine, subalpine tundra mountain meadow grassland
Resident trout	perennial stream, riparian
Aquatic macro-invertebrates	perennial stream, riparian

MIS are selected to monitor the effects of planned management activities on populations of fish and wildlife species. Monitoring MIS habitats and determining how habitat trends relate to population trends can help identify what impacts management activities have on wildlife and their habitats on the Carson National Forest. For species that are related to forested habitats, the actual tree data was examined to help determine suitable habitat and how to design the queries to best approximate acres of habitats as addressed in the Forest Plan EIS. Selected portions of each species’ write-up will be incorporated into the MIS Assessment to provide a summary of the habitat trend on the Carson National Forest.

BREWER'S SPARROW – HABITAT TREND ANALYSIS

Forest Plan Environmental Impact Statement (EIS) identifies sagebrush as the habitat type for this species (USDA 1986a, p. 97). At the time the Forest Plan was implemented, 52,600 acres of Brewer's sparrow habitat were identified for the Forest. It was expected that habitat would remain relatively consistent along with populations. Based on the current Geographic Information System (GIS) vegetation data layer, there is now a total of 81,752 acres of sagebrush.

This is mainly due to the large areas of revegetation treatments, which converted both piñon and juniper and sagebrush to grasslands in the 1960's. A total of 83,142 acres of these treatments (Management Area 11 in the Forest Plan) were not included in either the sagebrush or piñon/juniper habitats at that time. Many of the acres of both conversion types have gradually transitioned from grasslands to sagebrush, which accounts for the significant upward trend in habitat. Some of sites are shifting from sagebrush back to piñon-juniper. Others have been maintained by prescribed burning and are not expected to shift from grasslands to sagebrush.

It should be noted that many acres in the Forest Plan EIS identified as piñon-juniper habitat acres have a very strong sagebrush component. For example, sagebrush may actually be the dominant species in an area, but piñon-juniper may be present in sufficient abundance to provide the structural difference necessary to classify the site as piñon-juniper. No set criteria are provided for observers to breakout this particular transitional portion of the community. However, areas are often broken out based on the most structurally or visually influencing species. The Brewer's sparrow may occupy as much as two or three times the acres of monoculture sagebrush habitat present.

As of 2005, the numbers supporting this trend (above chart) have not changed from the 2003 Forest-wide MIS Assessment (USDA 2003b); however the amount habitat loss on the Jicarilla Ranger District was not entirely considered. The removal of sagebrush for gas extraction (road construction and well pad development) has increased over the past 2-3 years.

Project Level Effects Analysis

With regard to individual project effects analysis, the overall forest trend in habitats should be referenced against the acres classified as sagebrush. However the transitional sites mentioned above are likely to contain excellent habitat characteristics and be occupied by the species. A distinction should be drawn between the two and identified in the analysis. Such habitats should be addressed at a site-specific level including projected effects of bark beetle mortality.

JUNIPER TITMOUSE – HABITAT TREND ANALYSIS

Forest Plan EIS identifies piñon-juniper as the habitat type for this species. The key feature used in the EIS to track plain titmouse habitat was "piñon-juniper canopies" (USDA 1986a, p. 97). At the time the Forest Plan was implemented, 364,900 acres of plain titmouse habitat were determined for the Forest. However, the difference between 364,900 acres in the Forest Plan and the 355,409 identified in the vegetation cover data (USDA 2003a) is due to a variation in habitat typing. Since that time stands have grown, some have been harvested, wildfires and disease have changed the landscape to a limited degree and data to estimate conditions and cover types has also improved or changed in methods.

Several factors are used to determine habitat trend. Management activities (primarily timber sales) and wildfire have reduced certain habitats to unsuitable conditions. High intensity wildfire and certain harvest prescriptions such as overstory removal, seed cuts and shelterwood

harvests are examples of areas that are deducted from the total acres of titmouse habitat. Total stand acres are not deducted. Only the actual acres treated that are estimated to result in acres becoming unsuitable are subtracted. Suitable stands (2,620 ac) that had experienced wildfire or prescribed fire were removed from titmouse habitat. Suitable habitat lost to fuelwood cutting (4,060 ac) was also deducted.

The following table uses the Carson Forest Vegetation cover type mapping to determine acres of habitat. Adjustments are made based wildfire and fuelwood harvesting including various forms of type conversion in this habitat type.

Titmouse Suitable Habitat Acres: Change from Wildfire, Fuelwood Cutting, and Tree Growth 1986-2005

Ranger District	Total PJ Acres in 2002	Habitat Acres Reduced by Wildfire & Rx Burning	Habitat Acres Reduced by Fuelwood Cutting	Total Acres Reduced	Remaining Acres of Titmouse Habitat
D1, D2, D6[1]	204,328	20	1,500	1,520	202,808
D3	87,301	500	2,550	3,050	84,251
D4	41,444	100	300	400	41,044
D7	22,336	2,100	100	2,200	20,136
Total	355,409	2,720	4,450	7,170	348,239

The above table does not include an ingrowth factor, since this habitat grows very slowly and is not likely to be significant enough to consider. Also fuelwood harvest, as with logging practices, changed during the period of the Forest Plan. Removal of older, larger trees for fuelwood was a fairly common practice in the 1980's. Thus the assumption the Forest Plan EIS makes that fuelwood harvesting would result in a downward trend habitat. This was in part reversed by the early 1990's to maintain the larger trees and remove the crowding in the understory. The latter treatment would not affect the suitability of habitat for the juniper titmouse. The numbers above are estimated to reflect that trend. The table still reflects any harvest that would have removed or resulted in unoccupied habitat.

In this case, the trend in acres of habitat shows a decrease in acres from 364,900 to 348,729. However, it should be noted that the difference between 364,900 acres in the Forest Plan and the 355,409 identified in the vegetation cover data (see table) is due to a variation in habitat typing. There are often variations especially in the piñon-juniper sagebrush communities. For example, sagebrush may be the dominant species in an area but scattered piñon and juniper may actually provide the structural difference necessary to influence species diversity. There are no set criteria for observers to break out this particular transitional portion of the community.

The trend in habitat acres shows a decrease from 355,409 to 348,239. This is a downward trend of an estimated 7,170 acres, or about two percent of available juniper titmouse habitat on the Carson National Forest since 1986.

[1] D1 = Canjilon, D2 = El Rito, D3 = Jicarilla, D4 = Camino Real, D6 = Tres Piedras, D7 = Questa

Project level effects analysis

With regard to individual project effects analysis, there is no distinction as to quality of habitat in the Forest Plan EIS. It is likely that in the neighborhood of 15 to 20 percent of this habitat forest-wide provides poor to marginal habitat conditions. These stands are sparse and on low productivity sites with small trees. On the other hand, some transitional sites likely to be typed out as ponderosa may contain excellent habitat characteristics that are occupied and not included in these numbers. Along with the forest-wide habitat trend (which compares back to the Forest Plan EIS), such habitat factors should be addressed at a site-specific level, including projected effects of bark beetle mortality and the results of change due to the project.

ABERT'S SQUIRREL – HABITAT TREND ANALYSIS

There are two levels that need to be considered when looking at the ponderosa pine habitats across the Forest. First is the overall ponderosa pine habitat. This is important to help place the subset of interlocking canopies identified in the Forest Plan EIS in perspective. Although there are 301,297 total acres of ponderosa (based on current stand data cover types), the Forest Plan EIS identifies a subset of 53,220 acres of occupied Abert's squirrel habitat in the ponderosa pine. In 1986, when the Forest Plan was adopted, the key feature used to identify quality habitat was "interlocking canopies" (USDA 1986a, p. 97). Since that time, stands have grown, some have been harvested or burned, and data to estimate conditions has improved. Although there is important data forest-wide, the subset of interlocking canopies is the primary feature by which habitat trend for Abert's squirrel is tracked.

Several factors are used to determine habitat trend. Management activities (primarily timber sales) and wildfire have reduced certain habitats to unsuitable conditions. High intensity wildfire and certain harvest prescriptions such as overstory removal, seed cuts and shelterwood harvests are examples of areas that are deducted from the total acres of interlocking canopies. Total stand acres are not deducted. Only the actual acres treated that are estimated to result in acres becoming unsuitable are subtracted. The process to estimate current acres of interlocking canopies involve numerous steps which include:

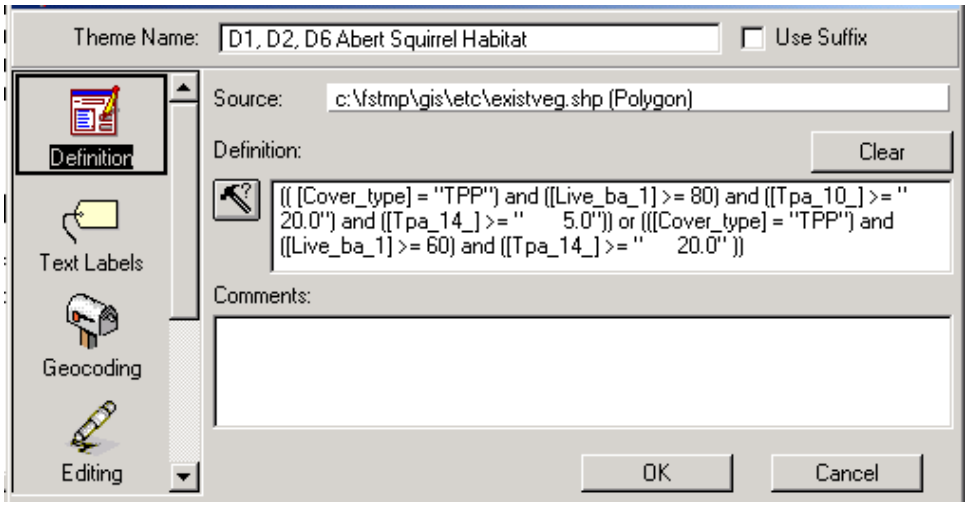
- *Select the stands from the RMRIS database and export to Arc View.*
- *Select the ponderosa pine vegetation cover type.*
- *Determine suitable Abert's Squirrel habitat by:*

  Selecting Ponderosa Pine stands with stand exam data.

  Creating fields with tree size information that includes trees per acre >10", >14", >16", >18" and >20" diameter at breast height (DBH).

  The tree size distribution data was reviewed to help select the query criteria for suitable habitat.
- *A query was developed that basically selects for Vegetation Structural Stage (VSS) 4 through 6. It was also designed to include number of high end VSS 3 stands with a strong component of larger trees that would provide suitable habitat with interlocking canopies. It is important to note that the distribution of tree size data was used instead of just a VSS query, as VSS data was not available on all the stands with stand exams and the actual size class distribution was likely to improve stand selection for suitable habitat.*

Query 1



- *The Forest was also divided into four separate areas with contiguous boundaries to evaluate stand data. These include: 1) Jicarilla (D3); 2) Camino Real (D4) 3) Questa (D7); 4) El Rito (D2), Canjilon (D1) and Tres Piedras (D6) Ranger Districts. This was done as habitats are more similar within these groups and the percentage of stands with exams will vary between these areas. Evaluating them separately prior to extrapolation and then totaling will increase reliability of the acreage estimates.*
- *The suitable habitat acres for each area were then factored by the acres of ponderosa pine without exams to get the estimated suitable habitat acres.*
- *These acres were then multiplied by the percentage estimated to have interlocking canopies.*
- *Then the high intensity fire acres were estimated along with the sale areas that reduce habitat values and subtracted.*

We also looked at the possibility of an adjustment in case the areas with stand exams may have been conducted on higher priority stands. After evaluation, it did not appear that this was the case and no adjustment was necessary.

Acreage Summary

Formula: $\frac{\text{Acres PP with stand exams}}{\text{Total acres PP}} = X\%$

$\frac{1}{x}$ = multiple factor

Total suitable Abert's squirrel habitat = multiple factor x acres of suitable squirrel habitat with stand exams.

Estimated Abert's Squirrel Habitat on the Carson National Forest in 2002

District	Total PP Acres	PP Stand Exam Acres	% of PP Acres with Stand Exams	Multiplier	Stand Exam Acres Meeting Squirrel Habitat Query Criteria	Gross Stand Acres of Squirrel Habitat	Net Acres of Squirrel Habitat
D1, D2, D6[1]	176,966	62,922	0.36	2.81	25,228	70,953	35,476
D3	33,905	0	0.00	-	-	13,458	6,729
D4	50,005	13,453	0.27	3.72	9,329	34,676	17,338
D7	40,421	28,363	0.70	1.43	7,018	10,002	5,001
						Total	64,544

The Jicarilla Ranger District has no stand exam data. However, it does have suitable habitat and huntable populations of Abert's squirrel. This population has largely developed after the Forest Plan implementation (1986). Field biologist observations indicate that Abert's squirrel occurs in most locations where ponderosa pine occurs. The distribution of Abert's squirrel is district-wide. A forest-wide ratio of average suitable habitat to total ponderosa pine acres from the remainder of the Forest is used to estimate suitable acres of habitat for the Jicarilla Ranger District.

Given the criteria for stand selection the average basal area (BA) across the forest will average around 110 in suitable habitats. The following are the average basal areas by unit area.

Table 1

Area	Avg. Basal Area
D1, D2, D6	108
D4	114
D7	111
D3	unavailable

Using the Regional conversion chart (unpublished), the crown cover will average just over 75 percent. It is estimated that interlocking canopies that allow for arboreal movement by squirrels will average at least 50 percent of each of the stands identified as suitable habitat.

Since the Forest Plan was first implemented, ponderosa pine stands have progressed toward more suitable habitat as a result of forest succession. A conservative estimate of stands moving into suitability from forest succession is five percent (see table below).

However, management activities (timber sales) and wildfire have reduced certain habitats to unsuitable. High intensity wildfire and certain harvest prescriptions such as overstory removal, seed cuts and shelter wood harvests are example of areas that are deducted from the total acres of interlocking canopies. Total stand acres are not deducted. Only the actual acres treated that are estimated to result in acres becoming unsuitable are subtracted.

The following chart is a summary table of adjustments to suitable acres of Abert's squirrel habitat during the life of the Forest Plan.

[1] D1 = Canjilon, D2 = El Rito, D3 = Jicarilla, D4 = Camino Real, D6 = Tres Piedras, D7 = Questa

Abert's Squirrel Suitable Habitat Acres: Change from Wildfire, Logging and Tree Growth 1986-2005

Ranger District	Total PP Acres	Estimated Acres of Habitat in 2002	Habitat Acres Reduced by Wildfire	Habitat Acres Reduced by Logging	Total Acres Reduced	Total Acres of Ingrowth (+ 5%)	Remaining Acres of Abert's Squirrel Habitat
D1, D2, D6	176,966	35,476	371	2,410	2,781	2,106	34,801
D3	33,905	6,729	22	0	22	399	7,106
D4	50,005	17,338	110	194	304	1029	18,063
D7	40,421	5,001	1,474	0	1,474	297	3,824
Total	301,297	64,544	1,977	2,604	4,581	3,831	63,794

The habitat trend for Abert's squirrel from 1986 to 2005 is estimated to have increased from 53,220 to 63,794 acres of interlocking canopies or an upward trend.

HAIRY WOODPECKER – HABITAT TREND ANALYSIS

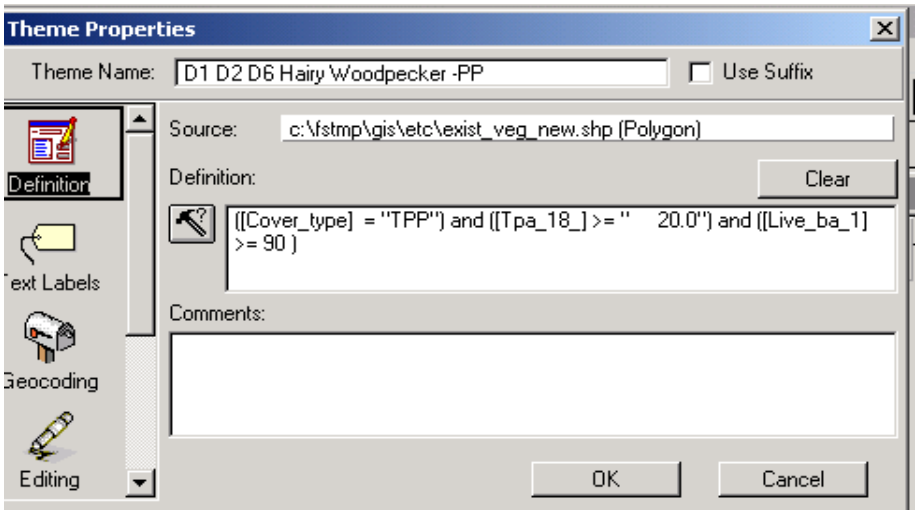
The key feature used in the Carson Plan EIS to identify quality hairy woodpecker habitat was "snags". There are two levels that need to be considered when looking at hairy woodpecker habitat across the Forest. First is the overall ponderosa pine and mixed conifer habitat. This is important to help place the subset of quality habitat in perspective. Although there are approximately 637,488 total acres of ponderosa and mixed conifer (based on current stand data cover types), the Forest Plan EIS identifies a subset of 106,880 acres of occupied hairy woodpecker habitat in the ponderosa pine and mixed conifer. According to the Forest Plan EIS, hairy woodpeckers will utilize mature and old growth stands of pine, fir and aspen (USDA 1986a, p. 97). Since 1986, stands have grown, some have been harvested or burned and data to estimate conditions has improved. Although there is important data forest-wide, the subset of snags is the primary feature by which habitat trend for hairy woodpecker is tracked.

Several factors are used to determine habitat trend. To determine a trend from the baseline in the Forest Plan EIS, the RMRIS database was used to select stands that mimic the general approach used to arrive at the original acre figure. Cover types were selected from the RMRIS database and exported to Arc View. Although mature stands were considered, the following queries were run to reflect stands with the highest potential for old growth and large snag availability.

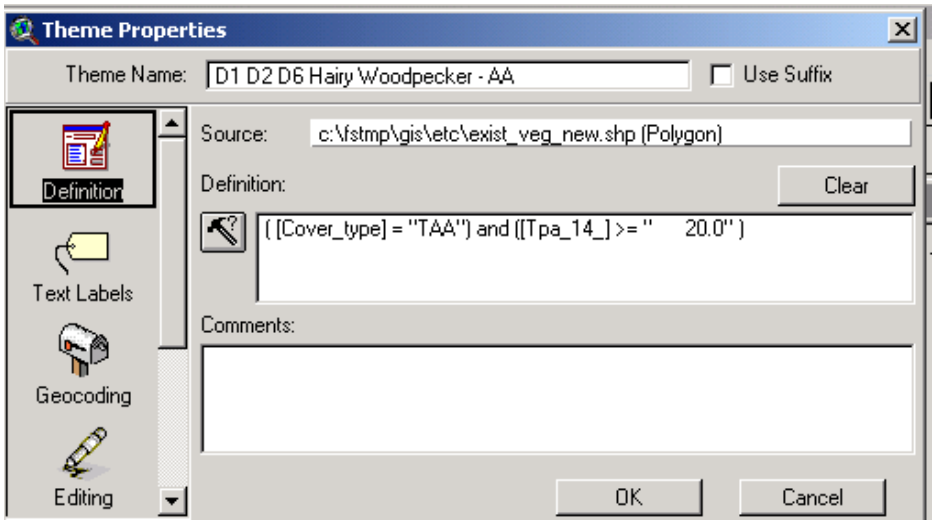
Management activities (primarily timber sales) and wildfire have reduced certain habitats to unsuitable conditions. High intensity wildfire and certain harvest prescriptions such as overstory removal, seed cuts and shelterwood harvests are examples of areas that are deducted from the total acres of quality hairy woodpecker habitat. Total stand acres are not deducted. Only the actual acres treated that are estimated to result in acres becoming unsuitable are subtracted.

Hairy Woodpecker Queries

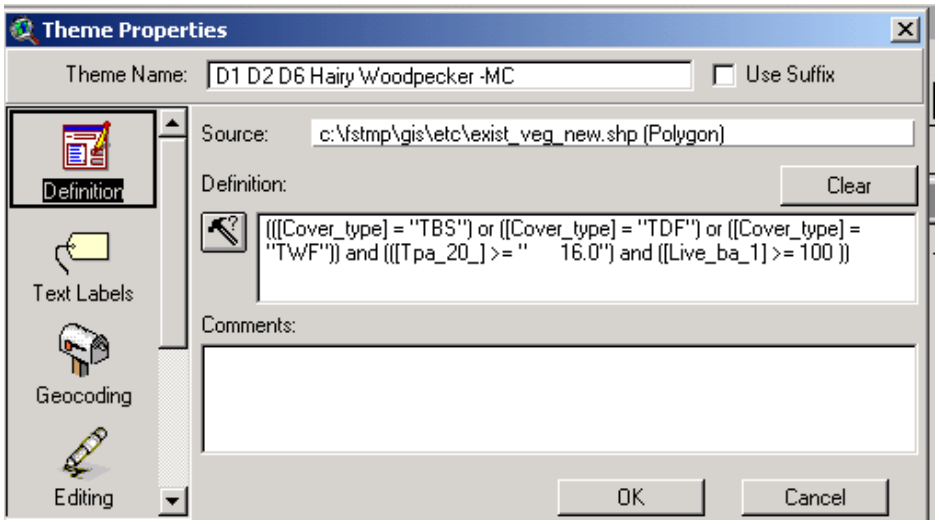
Query 1



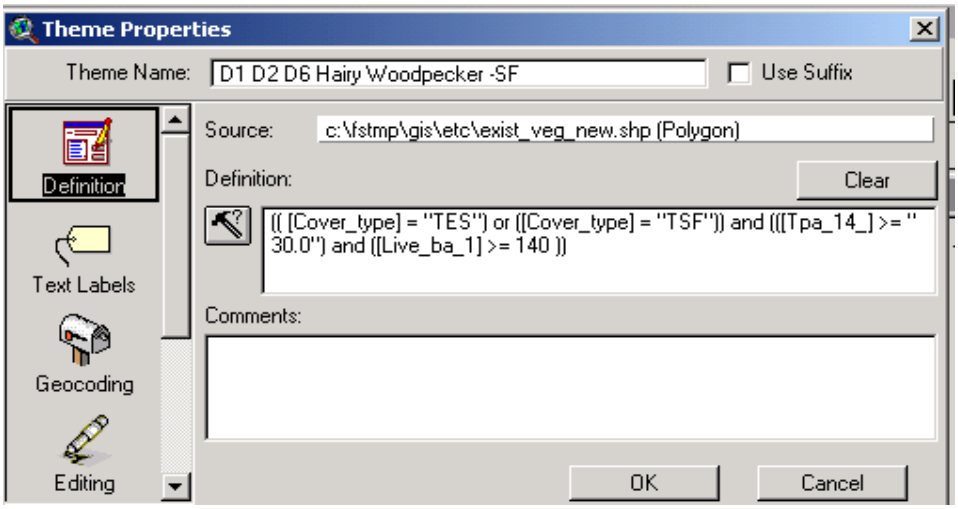
Query 2



Query 3



Query 4



Hairy Woodpecker Habitat in Ponderosa Pine

District	Total PP Acres	PP Stand Exam Acres	% of PP Acres With Stand Exams	Multiplier	PP Stand Exam Acres Meeting Hairy Woodpecker Habitat Query Criteria	Gross Stand Acres of PP Woodpecker Habitat	Total PP Acres In MA 17 & 20	% of PP Acres in MA 17 & 20	10% Acre Adjustment to Reflect Higher % of Habitat in Wilderness	Net Acres of PP Hairy Woodpecker Habitat
D1, D2, D6	176,966	62,922	0.36	2.81	472	1,327	799	0.5	80	1,407
D3	33,905	0	0.00	0.00	0	282	0	0.0	0	282
D4	50,005	13,453	0.27	3.72	241	896	1,173	2.3	117	1,013
D7	40,421	28,363	0.70	1.43	0	0	1,691	4.2	169	169
Total	301,297	104,738	0.35	2.88		2,505	3,663			2,871

Hairy Woodpecker Habitat in Mixed Conifer

District	Total MC Acres	MC Stand Exam Acres	% of MC Acres With Stand Exams	Multiplier	MC Stand Exam Acres Meeting Hairy Woodpecker Habitat Query Criteria	Gross Stand Acres of MC Woodpecker Habitat	Total MC Acres In MA 17 & 20	% of MC Acres in MA 17 & 20	10% Acre Adjustment to Reflect Higher % of Habitat in Wilderness	Net Acres of MC Hairy Woodpecker Habitat
D1, D2, D6	71,993	28,690	0.40	2.51	1,535	3,852	1,351	1.9	135	3,987
D3	1,943	0	0.00	0.00	0	59	0	0.0	0	59
D4	100,385	22,879	0.23	4.39	751	3,295	18,705	18.6	1871	5,166
D7	66,124	5,023	0.08	13.16	11	145	21,668	32.8	2167	2,312
Total	240,445	56,592	0.24	4.25		7,351	41,724			11,524

Hairy Woodpecker Habitat in Spruce-Fir

District	Total SF Acres	SF Stand Exam Acres	% of SF Acres With Stand Exams	Multiplier	SF Stand Exam Acres Meeting Hairy Woodpecker Habitat Query Criteria	Gross Stand Acres of SF Hairy Woodpecker Habitat	Total SF Acres In MA 17 & 20	% of SF Acres in MA 17 & 20	10% Acre Adjustment to Reflect Higher % of Habitat in Wilderness	Net Acres of SF Hairy Woodpecker Habitat
D1, D2, D6	49,470	3,189	0.06	15.51	733	11,371	17,954	36.3	1,795	13,166
D3	0	0	0.00	0.00	0	0	0	0.0	0	0
D4	72,998	6,326	0.09	11.54	2,831	32,668	29,791	40.8	2,979	35,647
D7	78,931	3,887	0.05	20.31	768	15,595	44,146	55.9	4,415	20,010
Total	201,399	13,402	0.07	15.03		59,634	91,891			68,823

Hairy Woodpecker Habitat in Aspen

District	Total AA Acres	AA Stand Exam Acres	% of AA Acres With Stand Exams	Multiplier	AA Stand Exam Acres Meeting Hairy Woodpecker Habitat Query Criteria	Gross Stand Acres of AA Woodpecker Habitat	Total AA Acres In MA 17 & 20	% of SF Acres in MA 17 & 20	10% Acre Adjustment To Reflect Higher % of Habitat in Wilderness	Net Acres of AA Hairy Woodpecker Habitat
D1, D2, D6	43,997	12,310	0.28	3.57	3,943	14,093	4,872	11.1	487	14,580
D3	0	0	0.00	0.00	0	0	0	0.0	0	0
D4	30,918	4,835	0.16	6.39	1,777	11,363	8,311	26.9	831	12,194
D7	21,192	1,026	0.05	20.65	68	1,405	13,052	61.6	1305	2,710
Total	96,107	18,171	0.19	5.29		26,860	26,235			29,484

Total Hairy Woodpecker Habitat

District	Total Acres	Gross Stand Acres of Woodpecker Habitat	Net Acres of Hairy Woodpecker Habitat
D1, D2, D6	342,426	30,643	33,140
D3	35,848	341	341
D4	254,306	48,222	54,020
D7	206,668	17,145	25,201
Forest Total	839,248	96,351	112,702

Hairy Woodpecker Suitable Habitat Acres: Change from Wildfire, Logging and Tree Growth 1986-2005

Ranger District	Total Acres	Estimated Acres of Habitat in 2002	Habitat Acres Reduced by Wildfire	Habitat Acres Reduced by Logging	Total Acres Reduced	Total Acres of Ingrowth (+ 1%)	Remaining Acres of Hairy Woodpecker Habitat
D1, D2, D6	342,426	33,140	0	579	579	331	32,892
D3	35,848	341	0	0	0	3	344
D4	254,306	54,020	0	305	305	540	54,255
D7	206,668	25,200	500	0	500	252	24,952
Total	839,248	112,701	500	884	1,384	1,127	112,444

Suitable stands (500 ac) that had experienced high intensity fire were removed from the woodpecker habitat. Suitable habitat lost to timber harvest (884 ac) was also deducted. Also taken into account was forest succession, where ponderosa pine and mixed conifer stands have progressed towards more quality habitat since 1986. Only one percent ingrowth rate was used as the dense nature of many of the stands result in significant competition and stagnation in those stands that are most likely to progress to old growth. To compound this situation, timber sale projects included the allocation old growth stands that did not meet old growth standards, but were the closest and/or the best stands within the project area. Although old growth allocation does not necessarily preclude forest management activities, allocated stands are usually set aside from these practices. These stands should probably have been the highest priority stands to thin from below and move or set on track towards actually progressing to a biological representation of old growth more rapidly.

The following is a summary of the acres logged through timber sales that were used in the calculations to determine the acres reduced. Those acres are reflected in the previous summary table.

Logging in Hairy Woodpecker Habitat in Areas with Stand Exams

District	Sale Name	Location/Site	Acres
D1	Ranas	1000650019	54
D1	Ranas	1000650001	42
D2	Felipito	2001210018	45
D2	Felipito	2001210031	30
D6	Little Tusas	6002030004	28

District	Sale Name	Location/Site	Acres
D1, D2, D6 Total			199
D4	Ojo Aspen	4042500017	33
D4	Ojos Ryan	4025400035	2
D4 Total			35
Forest Total			234

Logging in Hairy Woodpecker Habitat in Areas without Stand Exams

District	Sale Name	Estimated Acres
D2	Lonesome	50
D2	Pasture	100
D6	Banco Julian	100
D6	Broke Off	50
D6	Oso	80
D1, D2, D6 Total		380
D4	Alamitos	25
D4	Dropout	25
D4	Duran	10
D4	Osha	20
D4	Pichacho	20
D4	Quemado	20
D4	Warm Springs	150
D4 Total		270
Forest Total		650

Total Estimated Reductions in Hairy Woodpecker Habitat from Logging

District	Estimated Acres
D1, D2, D6	579
D3	0
D4	305
D7	0
Forest Total	884

Of the 884 acres, 234 were known from stand exams. However, it is thought that sales that did not have stand exams had acres that may have qualified as old growth that were also affected. The additional acres were based on professional estimates by sale area. Most of which occurred during the early years of the Forest Plan as most sales after 1990 avoided old growth stands.

From 1986 to 2005, the estimated habitat trend for hairy woodpecker on the Carson National Forest is from 106,880 acres to 112,014 acres of habitat, or an upward trend of 5 percent. It should be noted that these numbers reflect acres of the best condition habitats and are most comparable to the acres estimated at the time of the Forest Plan.

Project level effects analysis

With regard to individual project effects analysis, the overall Forest trend should be referenced along with a reference to snag availability within the project area. The trend analysis focused on old growth and not just on mature stands. This is partially due to the fact that "mature" stands may or may not contain quality snags, which was the intent of the Forest Plan, and "mature" can vary, making assessments much more ill-defined and difficult. Effects on overall Forest trend can be more easily assessed when considering old growth habitats. Again, there will be thousands of additional acres in various conditions and cover types that contain numerous snags that may be utilized by the hairy woodpecker.

RED SQUIRREL – HABITAT TREND ANALYSIS

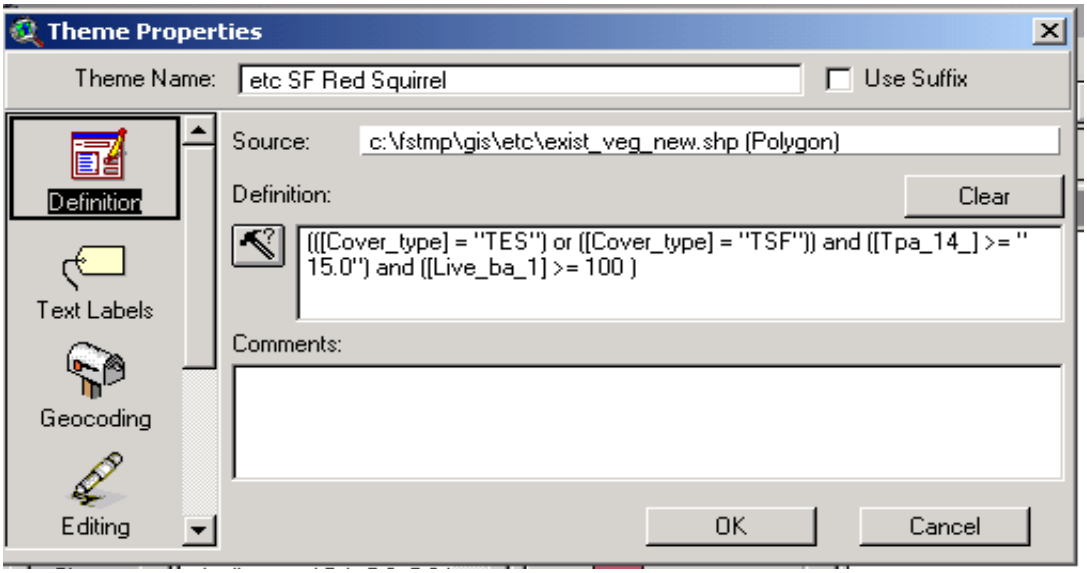
The Forest Plan EIS states red squirrel will utilize the mixed conifer habitat type (USDA 1986a, p. 97). No key habitat component was identified. However, the Forest Plan EIS estimates quality red squirrel habitat at 169,400 acres, which is only about half of the total mixed conifer on the Forest. This disparity seems to indicate that habitat quality parameters were the objective. The Forest Plan directs providing quality habitat in the mixed conifer and includes Engelmann spruce "in a wide variety of mixtures". The red squirrel is also known to utilize the spruce-fir habitat type. Some of the higher densities of squirrels are in this cover type. In the Southwest, Engelmann spruce or a mixture of spruce and Douglas-fir are the most important and commonly inhabited forest types for the red squirrel (Vahle 1978).

To determine a habitat trend from the baseline, the RMRIS database was used to select stands that, to the degree possible, arrive at the quality habitat objective. The cover types were selected from the RMRIS database and exported to Arc View. Then the following queries were run to reflect stands with the highest potential for the habitat attributes necessary for red squirrel occupancy.

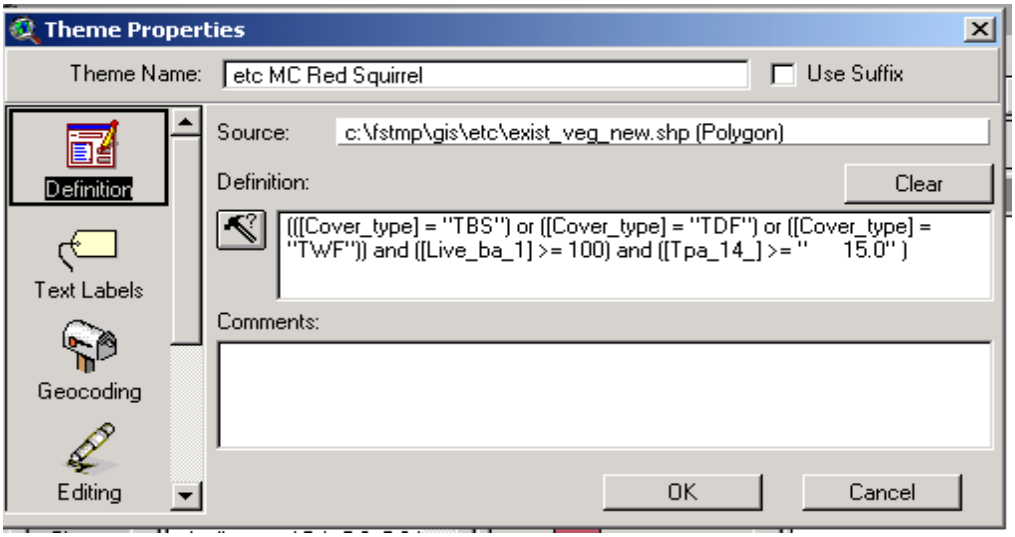
Red Squirrel Queries

To support the species, mature stands of mixed conifer and spruce-fir are important for adequate cone production, nest sites and canopy density. Queries were designed with these considerations in mind. They focus on mature or large tree components and a minimum basal area to provide adequate canopy closure.

Query 1



Query 2



Several factors are used to determine habitat trend. Management activities (primarily timber sales) and wildfire have reduced certain habitats to unsuitable conditions. High intensity wildfire and certain harvest prescriptions such as overstory removal, seed cuts and shelterwood harvests are examples of areas that are deducted from the total acres of quality mixed conifer and spruce-fir habitat. Total stand acres are not deducted. Only the actual acres treated that are estimated to result in acres becoming unsuitable are subtracted.

Suitable stands (2,580 ac) that had experienced high intensity fire were removed from squirrel habitat. In addition, suitable habitat lost to timber harvest (12,791 ac) was deducted. Also taken into account is forest succession, where mixed conifer and spruce-fir stands have progressed towards more quality habitat since 1986. A conservative estimate of stands moving to suitability is one percent of the overall mixed conifer and spruce-fir on the Forest.

In the following tables the total acres of habitat by cover type are identified from the GIS vegetation layer. The percentage with stand exams were totaled and then compared against the percentage meeting the habitat quality criteria and then extrapolated to estimate the total acres of red squirrel habitat.

Red Squirrel Habitat in Mixed Conifer

District	Total MC Acres	MC Stand Exam Acres	% of MC Acres With Stand Exams	Multiplier	MC Stand Exam Acres Meeting Red Squirrel Habitat Query Criteria	Gross Acres of MC Red Squirrel Habitat
D1 D2 D6	71,993	28,690	0.40	2.51	14,764	37,048
D3	1,943	0	0.00	0.00	0	933
D4	100,385	22,879	0.23	4.39	14,649	64,275
D7	66,124	5,023	0.08	13.16	1,000	13,164
Total	240,445	56,592	0.24		30,413	115,420

Red Squirrel Habitat in Spruce-Fir

District	Total SF Acres	SF Stand Exam Acres	% of SF Acres With Stand Exams	Multiplier	SF Stand Exam Acres Meeting Red Squirrel Habitat Query Criteria	Gross Acres of SF Red Squirrel Habitat
D1 D2 D6	49,470	3,189	0.06	15.51	2,051	31,817
D3	0	0	0.00	0.00	0	0
D4	72,998	6,326	0.09	11.54	4,064	46,896
D7	78,931	3,887	0.05	20.31	1,156	23,474
Totals	201,399	13,402	0.07		7,271	102,187

Total Red Squirrel Habitat

District	Total Acres	Stand Exam Acres Meeting Red Squirrel Habitat Query Criteria	Gross Acres of Red Squirrel Habitat
D1, D2, D6	121,436	16,815	68,864
D3	1,943	0	933
Total D4	173,383	18,713	111,171
Total D7	145,055	2,156	36,638
Forest Total	441,844	37,684	217,606

Red Squirrel Suitable Habitat Acres: Change from Wildfire, Logging and Tree Growth 1986-2005

Ranger District	Total MC and SF Acres	Estimated Acres of Habitat in 2002	Habitat Acres Reduced by Wildfire	Habitat Acres Reduced by Logging	Total Acres Reduced	Total Acres of Ingrowth thru 2005	Remaining Acres of Red Squirrel Habitat
D1, D2, D6[1]	121,463	68,864	0	7,357	7,357	818	62,318
D3	1,943	933	0	0	0	10	943
D4	173,383	111,171	80	4,072	4,152	1,320	108,339
D7	145,055	36,638	2,500	1,362	3,862	434	33,210
Total	441,844	217,606	2,580	12,791	15,371	2,582	204,873

There were a number of considerations that we examined, but decided not to use as modifiers to the acre calculations. One consideration was a deduction for those lower elevation mixed conifer stands that may have enough ponderosa pine to discourage red squirrel use. In conjunction, there are a few stands that are the highest elevation spruce-fir stands that may also not be as desirable. By examining the data, it could not be determined how much, if any, of a percent deduction should be made. On the other hand, standards were set fairly high for quality habitat, and it is likely some acres of habitat are not reflected in the totals. For example, there are only a hand full of stands that meet the 14-inch lower limit and do not have a number of trees that are 16 to 18 inches and larger in the stand.

[1] D1 = Canjilon, D2 = El Rito, D3 = Jicarilla, D4 = Camino Real, D6 = Tres Piedras, D7 = Questa

From 1986 to 2005, red squirrel habitat of interlocking canopies in mixed conifer and spruce-fir is estimated to have increased from 169,400 to 204,873 acres or an upward trend of about 20 percent. It is assumed that some of the increase is due to improved database and GIS capabilities not available at the time the Forest Plan was developed. However, the Forest Plan EIS (page 97) states, "a relatively consistent habitat is expected." It was thought that Forest habitat would be sustained at a projected rate of timber harvest. The actual rate of harvest has been substantially less than the projected for about a decade. This may also be a factor.

ROCKY MOUNTAIN ELK – HABITAT TREND ANALYSIS

The Forest Plan EIS identifies 1,362,760 acres as occupied habitat for elk on the Carson National Forest (USDA 1986a, p.97). The EIS projected an improvement in elk habitat conditions as the number of structural improvements (e.g., water developments) and nonstructural improvements (e.g. aspen regeneration) increased on the Forest (USDA 1986a, pp. 98 & 152).

In reviewing the management areas identified in the Forest Plan, sagebrush is not included in the acres of occupied elk habitat (USDA 1986c). Elk are currently utilizing the majority of the sagebrush habitat type on the Carson National Forest. Elk are extensively using the piñon-juniper woodlands intermixed with sagebrush, and in doing so, are also dispersing into the adjacent sagebrush habitat type.

The current vegetation cover type data shows 81,752 acres of sagebrush on the Forest, with the majority being on the Tres Piedras Ranger District. The District Biologist estimates that elk regularly use at least 75 percent of this cover type for several months to year-round. In addition, elk use virtually all of the sagebrush on the Jicarilla Ranger District (~6,500 acres). Forest-wide, it is estimated that elk habitat on the Carson National Forest has increased by 61,314 acres (75% of total sagebrush habitat). Forest-wide, it is estimated that elk habitat on the Carson National Forest has increased by 61,314 acres (75% of total sagebrush habitat). The trend for Rocky Mountain elk habitat from 1986 to 2005 is estimated to have increased from 1,362,760 to 1,424,074 acres or upward by almost 4 percent.

TURKEY – HABITAT TREND ANALYSIS

There are two levels that need to be considered when looking at the ponderosa pine habitats across the Forest. First is the overall ponderosa pine habitat. This is important to help place the subset of old growth identified in the Forest Plan EIS in perspective. Although there are 301,297 total acres of ponderosa (based on current stand data cover types), the Forest Plan EIS identifies a subset of 117,300 acres of occupied turkey habitat. According to the Forest Plan EIS, wild turkey utilize old growth stands of pine, but focus on roost tree availability as a key component or habitat group (USDA 1986a, p. 97). Although definitions for old growth have changed somewhat since 1986, there was and still is significantly less than 117,300 acres of old growth ponderosa pine.

By going back to the Analysis of the Management Situation document (USDA 1984, p. H-2) used in preparation of the Forest Plan, it was discovered that acres of turkey habitat were also taken from several "analysis areas" including aspen and mixed conifer. Since that time, stands have grown, some have been harvested, and some have experienced wildfire.

Methods for analyzing data to estimate habitat availability have also improved. Although there is important forest-wide data, the subset of roost trees is the primary feature by which habitat trend for Merriam's turkey is tracked. Queries were designed to replicate to the degree possible the intent of the Forest Plan by identifying stands with a high likelihood of providing roost trees or roost tree groups.

Several factors are used to determine habitat trend. Management activities (primarily timber sales) and wildfire have reduced certain habitats to unsuitable conditions. High intensity wildfire and certain harvest prescriptions such as overstory removal, seed cuts and shelterwood harvests are examples of areas that are deducted from the total acres of turkey habitat. Total stand acres are not deducted. Only the actual acres treated that are estimated to result in acres becoming unsuitable are subtracted.

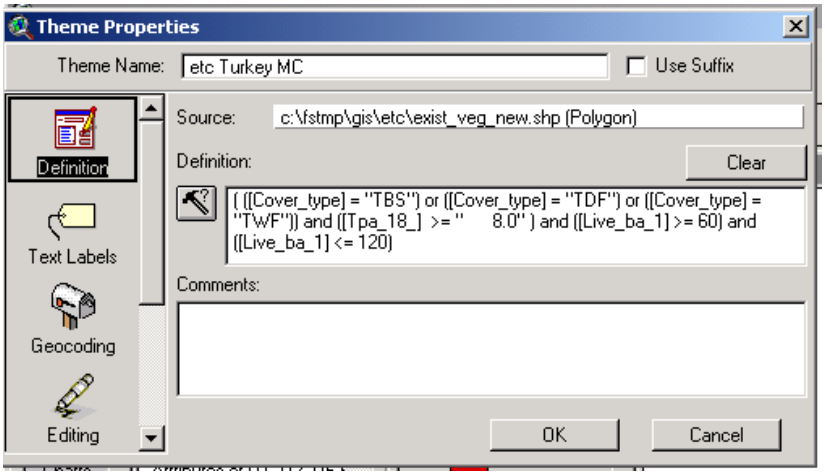
Suitable stands (4,000 ac) that had experienced high intensity fire were removed from turkey habitat. Suitable habitat lost to timber harvest (9,733 ac) was also deducted. Also taken into account is forest succession, where ponderosa pine stands have progressed towards more quality habitat since 1986. A conservative estimate of stands moving to suitability is one percent of the overall ponderosa pine on the Forest.

To determine a trend from the baseline, the RMRIS database was used to select stands that mimic to the degree possible the general approach used to arrive at the original acre figure. The cover types were selected from the RMRIS database and exported to Arc View. Then the following queries were run to reflect stands with the highest potential for the habitat attributes necessary or identified for turkeys.

Turkey Queries

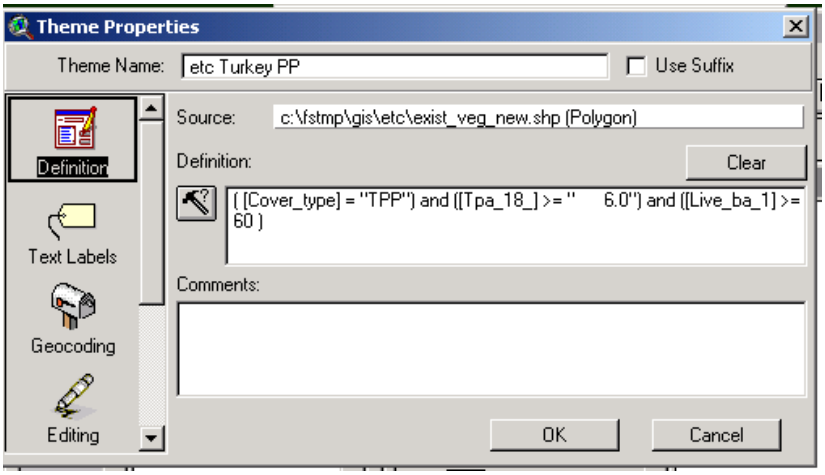
Given that roost tree availability was the primary consideration used to determine habitat during Forest Plan development, queries were designed with that consideration in mind. In addition, both an upper and lower basal area was used in the mixed conifer, since it is likely that extremely dense stands are not preferable to the species, but adequate cover in conjunction with roost tree availability was important.

Query 1

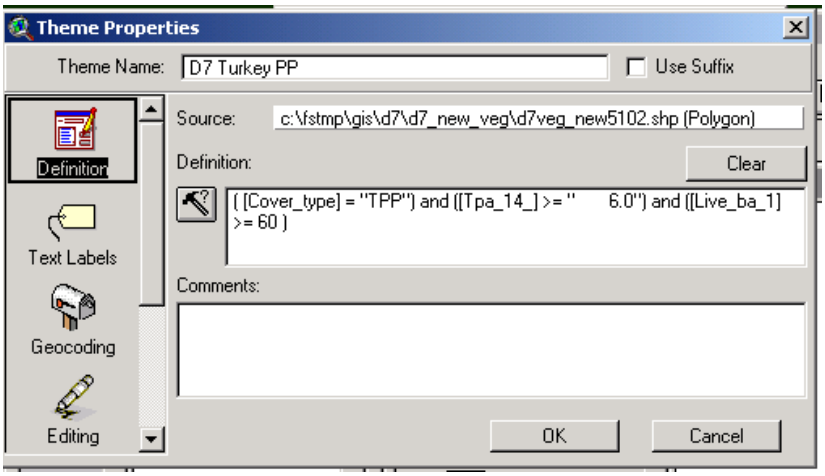


It is also likely that a few more large trees per acre may be required to provide an adequate roost tree or roost tree group in the mixed conifer. In the ponderosa pine the upper limit on the basal area was not considered as critical as the presence of enough large trees to provide for a roost tree or roost tree group per stand. The nature of the stands would not result in such a tight understory, which would inhibit movement, reduce forage and cause avoidance by turkeys.

Query 2



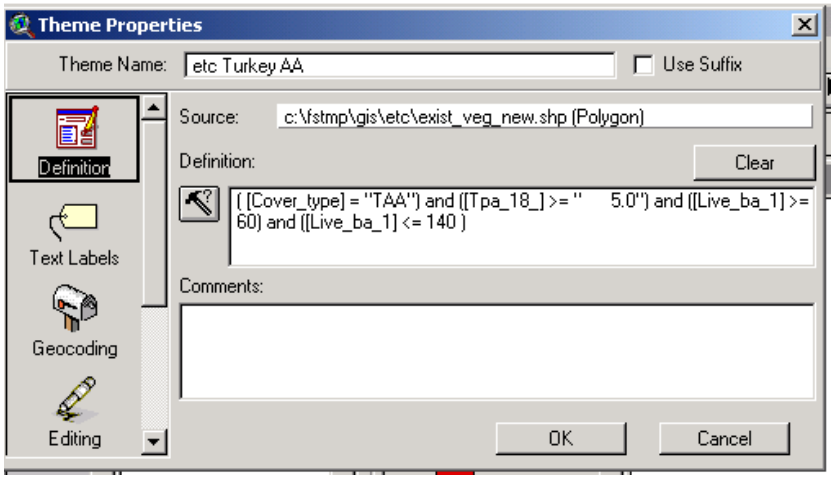
Query 3



The standards chosen for queries may appear to be more than required for turkey roost tree availability. However, one factor considered was that not all larger trees have turkey roost tree characteristics. In addition, we used a slightly less stringent standard for the Questa Ranger District. This reflects the smaller diameter classes on the Valle Vidal. This area does support turkeys and has a number of trees with turkey roost characteristics, but are just not as tall or have as large a diameter.

An upper limit on the basal area was also used in the aspen. This is primarily to eliminate stands that have a dense mixed conifer understory through forest succession, but might still type out as aspen. Also the more open grown stands provide for a slight increase in mixed species and more lateral branching that might be used for roosting along with the open understory necessary for foraging.

Query 4



The following three tables reflect the acreage calculations by cover type (ponderosa pine, mixed conifer and aspen) for wild turkey.

Turkey Habitat in Ponderosa Pine

District	Total PP Acres	PP Stand Exam Acres	% of PP Acres With Stand Exams	Multiplier	PP Stand Exam Acres Meeting Turkey Habitat Query Criteria	Gross Acres of PP Turkey Habitat
D1, D2, D6	176,966	62,922	0.36	2.81	21,441	60,302
D3	33,905	0	0.00	0.00	0	11,886
D4	50,005	13,453	0.27	3.72	5,956	22,139
D7	40,421	28,363	0.70	1.43	7,926	11,296
Total	301,297	104,738	0.35			105,622

Turkey Habitat in Mixed Conifer

District	Total MC Acres	MC Stand Exam Acres	% of MC Stands With Stand Exams	Multiplier	MC Stand Exam Acres Meeting Turkey Habitat Query Criteria	Gross Acres of MC Turkey Habitat
D1, D2, D6	71,993	28,690	0.40	2.51	2,903	7,285
D3	1,943	0	0.00	0.00	0	131
D4	100,385	22,879	0.23	4.39	1,505	6,603
D7	66,124	5,023	0.08	13.16	165	2,172
Total	240,445	56,592	0.24			16,191

Turkey Habitat in Aspen

District	Total AA Acres	AA Stand Exam Acres	% Of AA Acres With Stand Exams	Multiplier	AA Stand Exam Acres Meeting Turkey Habitat Query Criteria	Gross Acres of AA Turkey Habitat
D1, D2, D6	43,642	12,310	0.28	3.55	1,191	4,222
D3	0	0	0.00	0.00	0	0
D4	30,912	4,835	0.16	6.39	458	2,928
D7	21,192	1,026	0.05	20.65	0	2,033
Total	95,746	18,171	0.19			9,183

Total Turkey Habitat

District	Total Acres	Gross Acres of Turkey Habitat
Total D1, D2, D6	292,601	71,809
Total D3	35,848	12,016
Total D4	181,302	31,670
Total D7	127,737	15,500
Forest Total	637,488	130,995

Ranger District	Total MC, PP & AA Acres	Estimated Acres of Turkey Habitat in 2002	Habitat Acres Reduced by Wildfire	Habitat Acres Reduced by Logging	Total Acres Reduced	Total Acres of Ingrowth (+ 1%)	Remaining Acres of Turkey Habitat
D1, D2, D6	298,792	71,809	1,000	7,338	8,338	852	64,323
D3	35,848	12,016	0	0	0	142	12,158
D4	193,069	31,670	0	2,117	2,117	376	29,929
D7	131,752	15,500	3,000	278	3,278	184	12,406
Total	659,461	130,995	4,000	9,733	13,733	1,554	118,816

Turkey habitat from 1986 to 2005 is estimated to have increased from 117,300 to 118,572 acres or a slight upward trend of about 1 percent.

Project level effects analysis

When doing effects analysis at a project level, it should be kept in mind that the roost availability is only one of numerous habitat components that are necessary for stable turkey populations. Weak links in the composition of habitats should be determined. For example, the lack of roosting sites may be reduced by logging or fire, but if there are still adequate roost sites, the conversion of a portion of these acres to foraging areas may actually improve overall habitat condition. If roost sites are actually the weak link or limiting factor locally, then the trend in available habitat becomes more important.

Another consideration is acres of habitat forest-wide are also calculated by stand. If the stand is burned over by wildfire, those acres are deducted. This may in fact be beneficial for turkeys as

long as there is adequate roost tree habitat and the other required habitat components occur within about a half-mile.

ROCKY MOUNTAIN BIGHORN SHEEP – HABITAT TREND ANALYSIS

In New Mexico, suitable range for bighorn sheep is relatively limited. It is believed that bighorn once occupied alpine ranges in most of New Mexico, implying that the Pecos, Latir Peak, Wheeler Peak and Gold Hill areas of the Carson National Forest are historic ranges. The westside of the Carson NF lacks the high elevation, rugged habitat of cliffs, crags and rocky areas required to support a viable population of bighorn sheep.

The Forest Plan EIS identifies 20,430 acres of occupied bighorn sheep habitat on the Carson National Forest (USDA 1986a, p. 97). Based on Terrestrial Ecosystem Survey data, Map 1 displays only the alpine tundra portion (~ 10,100 acres) of bighorn habitat (USDA 1987). The Forest Plan EIS includes other adjacent alpine habitats; therefore the acres in Map 1 cannot be used in a habitat trend analysis. The core portions of bighorn habitat, however, can be located using Map 1, until a new map depicting a more accurate range of the species can be made available and incorporated into this document.

The Forest Plan EIS considered the bighorn herd in the Pecos Wilderness to be unstable and that a downward trend was expected (primarily due to lungworm-pneumonia disease) (USDA 1986a, p. 98). Conversely, populations have done very well on the Forest and several relocations have been successful.

Livestock grazing has been the only management activity that has significantly changed potential bighorn habitat during the period of the Forest Plan. The removal of domestic sheep from the Latir Peak range has without doubt increased the habitat quality, but it is not certain if the acres identified in the Forest Plan included this area. Actual occupied habitats should be remapped and key or critical areas identified for this species.

Currently, reproduction is high and mortality of young has not been significant. If this trend stays consistent the actual occupied range may gradually increase although there are natural limits.

Habitat conditions in the Pecos Wilderness are fair and stable, while the Wheeler Peak Wilderness, Columbine-Hondo Wilderness Study Area and the Latir Peak Wilderness are generally good and stable. There are a few locations where utilization is heavy, but these are isolated. The limiting factor for the bighorn is severe winter conditions when quality and quantity of forage can fluctuate significantly. Recent Forest Service management trends places more emphasis on thinning conifer encroachment and prescribed burning in transitory range, thus improving the quality of bighorn sheep habitat. The habitat trend for Rocky Mountain bighorn on the Carson National Forest is estimated to be stable.

WHITE-TAILED PTARMIGAN – HABITAT TREND ANALYSIS

White-tailed ptarmigan is associated with the alpine tundra and subalpine deciduous shrub. The Carson Forest Plan EIS identifies 6,400 acres of occupied habitat (USDA 1986a, p. 97). It also states that habitats are marginal compared to areas further north in Colorado, and that localized extinctions of populations could occur when densities are low.

No management actions have changed since the time of the Forest Plan to cause a change in the number of acres of available habitat on the Carson National Forest. The Terrestrial Ecosystem Survey data layer identifies that there are 10,106 acres of alpine tundra on the Forest (USDA 1987). This does not mean there is any change in the trend of available habitat,

but is a result of a variation in habitat mapping. Incidental observations show that portions of these habitats are still occupied. The most recent reports (photo verified) were in the Pecos Wilderness in 2002. The overall habitat trend for the white-tailed ptarmigan on the Carson National Forest is stable.

RESIDENT TROUT AND MACROINVERTEBRATES – HABITAT TREND ANALYSIS AND OTHER MONITORING DATA

Resident trout include all species of salmonids on the Carson including native and non-native species. Both resident trout and macroinvertebrates were based on the total length of stream miles or available habitat and were estimated at 400 miles. The Forest Plan EIS identifies 400 miles of occupied habitat. The total number of stream miles has not changed since the Plan was prepared. However, the data processing and GIS capabilities have resulted in a refinement of the actual occupied habitat to approximately 444.26 miles. **Habitat trend for both resident trout and aquatic macroinvertebrates on the Carson National Forest is stable.**

Even though the trend in habitat is stable, habitat monitoring has also led to a much more precise breakdown of occupied habitats between Rio Grande cutthroat (Forest Service Sensitive) and other non-natives such as brook trout, brown trout and rainbow trout. The following table is a summary of both native and non-natives by stream miles by watershed on the Carson National Forest.

Stream Miles for Native and Non-Native Trout Species on the Carson National Forest

Stream Name	Miles			
	Restoration Potential	RGCT Only	Non-Native Only	RGCT & Non-Native
Rio de los Piños (13010005050)[1]				
Rio de los Piños	3.25		3.35	
Lobo Creek	1.76		1.76	
Diablo Creek	2.58		2.58	
Escondido Creek	1.27		1.27	
Beaver Creek	4.79		4.79	
Cruces Creek	2.53		2.53	
Tanques creek		1.96		
Rio Nutrias	3.87	2.49	3.87	0
Rio San Antonio	15.63		15.63	
Lagunitas Creek	5.2		5.2	
Canada Tio Grande	5.09	4.46	5.09	1.34
Total	45.97	8.91	46.07	1.34
El Rito Creek (13020102090)				
Canada Chacon		2.31		
Hachita Canyon		2.14		
Salvador Canyon		1.65		
Gurule Canyon		1.83		
El Rito Creek		8.23	4.48	
Total	0	16.16	4.48	0
Canjilon Creek (13020102060)				
Canjilon Creek		5.83		
Total	0	5.83	0	0
Rio Tusas/ Vallecitos (13020102080)				
Jaroso Creek		1.56		
Total	0	1.56	0	0
Rio Costilla (13020101010)				
La Cueva Canyon		2.27		
Comanche Creek		9.93		
Vidal Creek		5.03		
Chuck Wagon Creek		2.47		
Gold Creek		3.12		

[1] Watershed Hydrologic Unit Code

Stream Name	Miles			
	Restoration Potential	RGCT Only	Non-Native Only	RGCT & Non-Native
La Belle Creek		2.79		
Grassy Creek		3.06		
Holman Creek		2.99		
Spring Wagon Creek		2.96		
Little Costilla Creek		4.74		
Powder House Creek		4.64		
Rio Costilla	5.17	5.17		5.17
Total	5.17	49.17	0	5.17
Vermejo (11080001010)				
Leandro Creek		2.5		
Total	0	2.5	0	0
Ponil (11080002010)				
North Ponil Creek	3.4	2.67	0.89	3.4
McCrystal Creel		4.79		
Total	3.4	7.46	0	0
Red River (13020101040)				
Bitter Creek		4.64		
Jiron Creek		2		
Cabresto Creek	7.75	7.9	8.9	5.34
Lake Fork Creek	2.56	2.83	2.35	1.71
Deer Creek		1.19		
Place Fork Creek		3.56		
Willow Fork Creek		1.97		
Columbine Creek		4.99		
West Fork Creek	1.74		1.74	
Middle Fork Creek	1.27		1.27	
Sawmill Creek	1.17		1.17	
East Fork Creek	2.68		2.68	
Red River	18.28		18.28	
Pioneer Creek		5.01	5.01	
Total	35.45	34.09	41.4	7.05
Rio Hondo (13020101050)				
San Cristobal Creek		5.18		
Yerba Canyon		2.91		
Manzanita Canyon		2.61		

Stream Name	Miles			
	Restoration Potential	RGCT Only	Non-Native Only	RGCT & Non-Native
Italianos Canyon		2.25		
Gavilan Canyon		1.96		
South Fork Rio Hondo		4.4		
Rio Hondo	9.74	3.65	6.54	3.65
Total	9.74	22.96	6.54	3.65
Rio Grande del Rancho (13020101060)				
Rio Fernando		3.18	1.93	
Valle Largo		0.67	0.88	0.76
Osha Pass		0.86	1.09	1.11
Tienditas Creek		2.84	1.86	1.03
Rio Chiquito	15.6		15.6	
Palociento Creek		2.46		
Frijoles Creek	1.52	0.7	1.52	1.36
Rito de la Olla	11.93	2.1	11.25	0.68
Rio Grande del Rancho	11.81		11.81	
Jarosa Canyon		1.55		
Saloz Canyon		1.36		
Totals	40.86	15.72	45.94	4.94
Rio Pueblo (13020101070)				
Sardinas Canyon	1.37	1.75	0.54	1
Rito La Pressa	2.96	2.49	1.27	1.5
Policarpio Canyon		2.25	0.21	0
Arellano Canyon	1.54		1.54	
La Junta Canyon	5.36		5.36	
Duran Creek	1.74	1.26	0	1.48
La Cueva Canyon		3.21		
Osha Canyon		4.6		
Comales Canyon		3.65		
Cordova Canyon		1.81		
Agua Piedra Creek	0.81	2.88	0	0.81
Rito Angostura		5.66		
Alamito Creek	4.62	4.62	4.62	0
Raton Canyon	1.46		1.46	
Rio Pueblo	5.46		5.46	
Indian Canyon		1.7		

Stream Name	Miles			
	Restoration Potential	RGCT Only	Non-Native Only	RGCT & Non-Native
Jicarita Creek		2.26		
East Fork Rio Santa Barbara	0.41	2.45	0	0.41
Middle Fork Rio Santa Barbara	3.62	3.13	0	3.62
West Fork Rio Santa Barbara	4.31	0.86	0	4.31
Rio Santa Barbara	5.37	0	1.09	4.03
Rio Chiquito	5.84		5.84	
Rio San Leonardo		3.54	3.54	
Total	44.87	48.12	30.93	17.16
Sabastian Martin (13020101090)				
La Jara Canyon		1.68	0	3.52
Rio De Truchas		1.53	0	3.69
Total	0	3.21	0	7.21
Upper Mora (11080004010)				
West Fork Luna Creek		2.29		
East Fork Luna Creek	2.76	0.74	0	2.76
Total	2.76	3.03	0	2.76
Coyote (11080004020)				
Jarosa Creek		0.9		
Total	0	0.9	0	0
Grand Total	*188.22*	*219.62*	*175.36*	*49.28*

Note: The first column or “Restoration Potential” is contained in the other column numbers: 219.62 + 175.36 + 49.28 = 444.26 miles.

General Assemblages of Aquatic Macroinvertebrates on the Carson National Forest

Station	Date	Sample ID	Total Abundance	EPT Abundance	# of Families	Dominant Family	Dominant Family Abundance	Dominant Family % Contribution
COMANCHE01	06/08/1998	108762	1054	688	14	Leptohyphidae	326	30.93
COMANCHE01	09/26/1982	112790	519	144	12	Elmidae	168	32.37
COMANCHE02	06/30/1998	108763	2398	2000	16	Heptageniidae	1072	44.70
COMANCHE03	06/30/1998	108764	2319	1642	15	Heptageniidae	649	27.99
COMANCHE04	07/02/1998	108765	2301	1735	17	Heptageniidae	821	35.68
COMANCHE05	07/10/1998	108766	1487	1223	13	Leptohyphidae	568	38.20
COMANCHE05	09/26/1982	112791	1500	906	13	Hydropsychidae	501	33.40
COMANCHE06	07/10/1998	108767	2294	1892	19	Lepidostomatidae	961	41.89
COMANCHE07	07/10/1998	108768	2333	2057	13	Lepidostomatidae	796	34.12
COMANCHE08	06/08/1998	108769	2652	1326	17	Chironomidae	1039	39.18
COMANCHE08	09/24/1982	112792	771	555	14	Glossosomatidae	225	29.18
COMANCHE20	06/09/2001	116366	620	358	12	Chironomidae	129	20.81
COMANCHE21	06/19/2001	115209	2544	2072	18	Heptageniidae	701	27.56
COMANCHE22	06/19/2001	115210	4579	2169	16	Chironomidae	1914	41.80
CWAGON-01	09/15/1998	108758	541	301	15	more than one	161	29.76
CWAGON-01	09/26/1982	112793	276	90	9	Chironomidae	9	19.57
ELRITO-A	07/16/2001	115199	2728	1914	9	Lepidostomatidae	1018	37.32
ELRITO-B	07/16/2001	115200	1208	885	10	Lepidostomatidae	427	35.35
ELRITO-C	07/16/2001	115201	2295	1427	15	Lepidostomatidae	983	42.83
ELRITO-D	07/16/2001	115202	1781	1409	9	Lepidostomatidae	871	48.91
ELRITO-E	08/03/2001	115203	294	204	15	Helicopsychidae	75	25.51
ELRITO-F	08/03/2001	115204	767	584	17	Heptageniidae	158	20.60
ELRITO-G	08/03/2001	115205	240	90	14	Chironomidae	72	30.00
FERNANDZ01	07/10/1998	108760	1118	452	14	Chironomidae	351	31.40
FERNANDZ01	09/26/1982	112794	405	144	8	Elmidae	195	48.15
LITTCOST01	07/31/1998	108759	215	100	11	Elmidae	82	38.14
LITTCOST01	09/26/1982	112795	612	198	12	Simuliidae	174	28.43
POT-01	09/04/2001	116363	1308	566	13	Chironomidae	627	47.94
POT-02	9/04/2001	0116364	935	624	16	Chironomidae	237	25.35
POT-03	09/06/2001	116365	1254	724	19	Chironomidae	323	25.76
POWDER-01	06/26/1997	103966	190	168	10	Heptageniidae	86	45.26
POWDER-01	09/11/1997	103967	179	68	14	Elmidae	79	44.13
POWDER-01	07/15/1998	108774	2312	523	15	Simuliidae	1068	46.19
POWDER-01	09/10/199	108775	566	258	12	Elmidae	240	42.40
POWDER-01	09/24/1982	112797	180	165	12	Baetidae	51	28.33
POWDER-01	08/24/1999	115206	409	269	9	Heptageniidae	211	51.59
POWDER-02	09/11/1997	103968	276	154	17	Elmidae	72	26.09
POWDER-02	09/08/1997	103970	656	276	20	Elmidae	294	44.82

Station	Date	Sample ID	Total Abundance	EPT Abundance	# of Families	Dominant Family	Dominant Family Abundance	Dominant Family % Contribution
POWDER-02	07/15/1998	108772	430	165	14	Elmidae	183	42.56
POWDER-02	09/10/1998	108773	867	401	13	Elmidae	315	36.33
POWDER-02	08/24/1999	115207	602	373	12	Heptageniidae	297	49.34
POWDER-03	09/11/1997	103969	441	158	15	Elmidae	158	35.83
POWDER-03	09/08/1997	103971	538	183	15	Elmidae	258	47.96
POWDER-03	07/15/1998	108770	1233	373	16	Chironomidae	430	34.87
POWDER-03	09/10/1998	108771	1072	487	16	Elmidae	441	41.14
POWDER-03	08/24/1999	115208	391	229	10	Heptageniidae	161	41.18
RRBELOW	07/17/1998	106628	369	237	5	Brachycentridae	190	51.49
RRDEBRIS	08/08/2000	112605	43	39	4	Ephemerellidae	25	58.14
RRDOWNMINE	07/16/2000	112606	681	462	10	Brachycentridae	254	37.30
RRDOWNMINE	08/08/2000	112607	581	520	10	Brachycentridae	344	59.21
RRDOWNMINE	09/23/2000	112608	340	305	9	Brachycentridae	151	44.41
RRTOWN	07/17/1998	106629	151	129	7	Brachycentridae	90	59.60
RRUPMINE	07/16/2000	112609	896	814	8	Brachycentridae	333	37.17
RRUPMINE	07/16/2000	112610	262	208	8	Baetidae	86	32.82
RRUPMINE	09/23/2000	112611	509	412	11	Baetidae	172	33.79
TIOGRAN-01	07/26/2001	115211	1115	634	15	Heptageniidae	495	44.39
TIOGRAN-02	07/26/2001	115212	491	312	11	Heptageniidae	168	34.22
TIOGRAN-03	07/26/2001	115213	710	552	15	Heptageniidae	419	59.01
VIDAL01	06/08/1998	108761	3074	1333	19	Chironomidae	921	29.96
Mean			1066	656	13		401	37.62

Abundance data is number per meter squared for quantitative samples and number per sample for qualitative samples. NC = Not calculated. * = unable to calculate. EPT = totals for the insect orders